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Transitions in the Design Process

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Transitions in the design process

by

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ABSTRACT

The proposed research uses empirical methods to investigate designers' use of research throughout the design process with an emphasis on research and idea generation. The goal is to explore the factors which impact the various phases of the design process. The early phase of the design process is often referred to as the "fuzzy front end" where many variables are still in play and the design direction is not completely agreed upon. This is also when the designer is conducting user research. The connection between the user research and the design solutions that designers move forward is critical. This connection creates a space in which the designer can ensure they are approaching this process as a user-centered process.

This research explores these topics through observation of junior level industrial design students at one Midwestern university in a project-based design studio and takes place for the duration of one project. A total of four students were observed. The structure was set up that they were a team for early research, then splitting into three separate projects where two students worked together and two worked individually.

The researcher's observations for each designer are then followed up by a reflection interview in which the designer was asked to reflect on their own design process and to investigate their thought processes in choosing which research information they felt applied to their solutions and how this implementation might impact the outcome. This method is used to observe actions and behaviors during the design process allowing for observation of designers in their natural setting.

Therefor the question of what happens to research throughout the design process is explored. Building on new research in cognitive and decision sciences, along with studies of

design students, the goal is to study the role of research throughout the design process. Possible application of this research would be in developing a framework that demonstrates implementation techniques of this knowledge for new teaching methods, among others.

CHAPTER 1

INTRODUCTION

This study considers the question of what happens to research throughout the design process. In addition, it explores the factors that impact the various phases of the design process. The problem addressed by this research is the varying design processes of industrial design students, specifically at the junior level- or third year. Students were observed in a design studio in Fall semester, 2016. The use of research by each student observed differs from each other and from the way the design process is taught. This is connected to each individual's strengths, weaknesses, likes, dislikes, and experience with design research, synthesis, idea generation, and refinement.

Double Diamond Process

We begin by looking at the design process as it is taught to industrial design students in the class observed. The studio observed uses the Double Diamond Process (Service Design Vancouver, 2014), as a guideline for the project structure, as it is a well-known and commonly accepted method to base one's design process on in the field of industrial design.

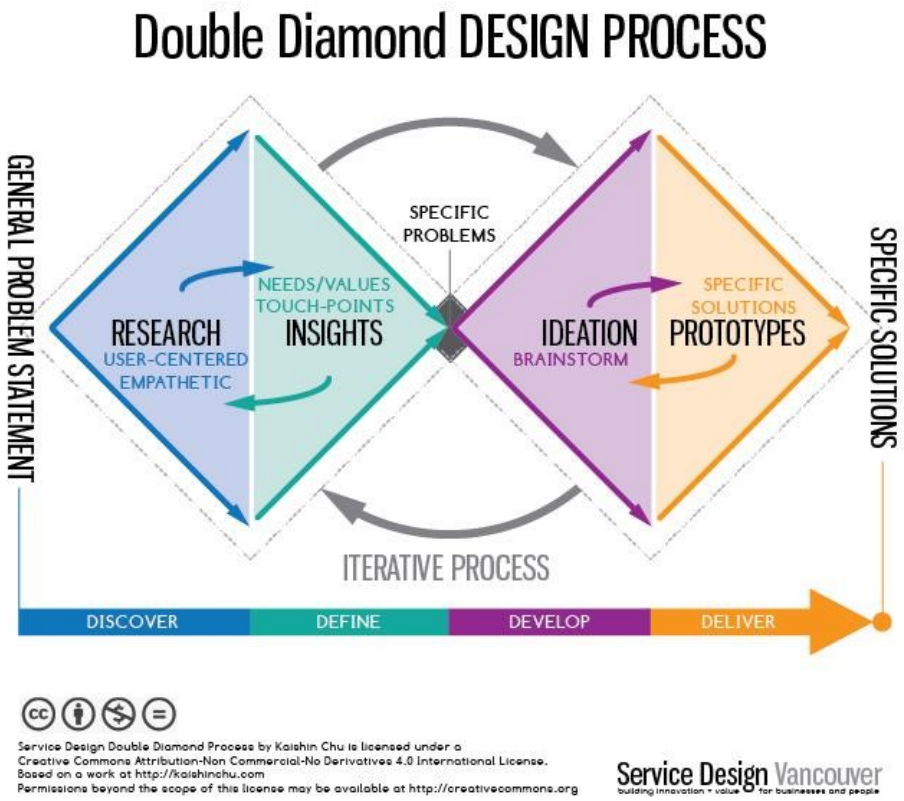

Figure 1. *Double Diamond Process – This is a chart showing the design process as taught in the course observed for this study (Service Design Vancouver, 2014)*

It is separated into two distinct sections, each in the shape of a diamond which is then further sub-divided into two more phases, for a total of four phases. These phases are Research, Insights, Ideation, and Prototype. The diamond shapes exist to signify the amount or broadness of the work produced in any given phase. For example, Research is the left side of the diamond, getting larger as you go through it. This is to signify that the data collected at this stage is very broad and the designer will have collected a large amount of data. The next phase, Insights, begins to narrow to the center point. This is to signify that the research is then analyzed and synthesized into smaller points, information which can be used directly in line with Ideation, the next phase. There are arrows showing potential routes through the process, essentially there to

state that one might go back and forth between phases as an “iterative process” (Service Design Vancouver, 2014). An iterative process would be when the designer repeats back into phases they have already explored. For example, after completing research, analysis and synthesis, and ideation, the designer might go back and do some focus groups which fall into the research category to determine users’ preferences on a concept or to see how they use a product they have designed.

Regarding the two diamond shapes, it appears as if the two diamonds are two separate, larger phases which when the first condenses to a point a new phase is started. This can lead to some confusion and misuse of the project in terms of how designers might perceive the chart and interpret it into what they should be doing. For example, one might interpret it to mean that because the first diamond has condensed to a point and the second diamond begins, these two parts are entirely separate, then leading to the first diamond of the process to be left behind as they move into the second diamond of the process. “Leaving behind” the research in this sense does occur for some students as they move into ideation because research is viewed as entirely separate from ideation. The arrows designated as “iterative process” (Service Design Vancouver, 2014) are there to suggest that this is not the case, however, they remain too subtle while the diamonds coming to an end are a much bolder statement.

There is another arrow below with a different set of words which line up with the above diamond-shaped phases. These are Discover, Define, Develop, and Deliver. (Service Design Vancouver, 2014) These are meant to put each phase into other words, almost a second definition of what is happening during that given phase of the process.

Each section of the diamond, or phase, is of equal volume, signifying that each phase might be equal to each other in importance, time, or value. However, this is not always the case.

Many factors contribute to the importance of each phase and the amount of time spent on each phase. In some cases, some phases are even skipped altogether depending on the needs of the project.

All in all, this depiction of the design process can be very confusing with its many parts. However, it tries to be concise, giving the designer multiple ways to view the process and to learn the process.

For this study, the double diamond process was used as a model because it was used by the instructor to structure the project after. It will be used as a base comparison at times to help describe the differences among student's own process and compared against that of the intended process.

Assumptions

An important factor to consider in the context of this research is the expectations of the instructor, students, designers, or anyone carrying out the design process in this manner. This begins with the expectation that research must be done as a part of the design process. Many times a product developed by a student within a studio project is not considered a "good" design if it has not been thoroughly researched first. Without research it is said that it is difficult to justify the designers ability to meet the needs of the user.

It is also assumed that the research is the most important or the main focus of the project. It will improve the design and therefore the research is ongoing and must be referenced throughout the project, basing the design on the research in order to justify every decision made. The heavy focus on research is in part an effect of using the double diamond process but also because that is what is taught at this university.

In line with this is the idea that instructors expect students to use the research they conduct. The research should be useful to them. It is expected that design decisions are clearly based on insights that are taken directly from the research they conducted. If a design does not develop out of this research but rather something else, the student has not successfully completed the design process.

Research Question

The main research question being addressed is: What is the role of research throughout the design process? This is explored through an observational study. What factors impact the creation and use of research? Do students just bottle up data collected during research and forget about it or are there are factors involved in the lack of use of data when ideating? Questions such as these are explored with this study.

In chapter one the background information needed to understand the problem is addressed. Chapter two focuses on past research related to the study, including the topics of fixation, the creative leap, and synthesis. Chapter three focuses on methods, observation and a reflection interview. Chapter four presents the results. Presented is the project the students completed, the timeline of the project, the timelines of each student, examples of the work each student completed, and the themes developed based on the data collected. Chapter five discusses the themes along with examples of students work, limitations of the study, and future work.

CHAPTER 2

LITERATURE REVIEW

Lost Research

A common problem that occurs within the design process is that the research is conducted, analyzed in some way, and then gets forgotten or bottled away as the designer moves on to the next stage of the design process. “Successful designers are optimists, exploring hopefully, dedicated to the task in hand. And, like all good explorers, they are opportunists, taking advantage of any unexpected openings or vantage point, and spotting what look like fruitful ways ahead.” (Cross, 2011, p. 14) While this is a great advantage to designers, being able to spot even the smallest opportunities and have the ability to take advantage of them in order to further the design, there is the chance of the opposite happening. This optimism can happen in a sense that they take the opportunity of a new, “cool” idea even if it does not truly fulfill the requirements presented by the research. The opportunity of a good idea, whether good in the context of the problem or not, can become the opportunity pursued if presented as the “best” option. As this is done, the research begins to fall into the background.

For example, during ideation a variety of solutions will be drawn. When the designer has a favorite drawing, that drawing may appear as the best option because the most amount of effort went into this drawing. That drawing may be the best option but in other cases it may be a favorite because it was more fun to draw, it looked better, or for any variety of other reasons. This idea then ends up chosen as the solution to move forward because it appears as the best even when it may not solve the problem at hand. As the new idea takes shape the research may be left behind, bottled away, or forgotten.

This problem often occurs in the design studio classroom and takes place after the user research or design research is conducted. By the time concept generation comes around and nears completion it is often questioned where the research went or what it even said. The research is long forgotten by then, recovered later on at the end when it is time to evaluate the process from start to finish. Why then, do designers spend all of this time "exploring", building up their research, only to forget about it when they get into the heart of concept generation?

Creative Leap

"Creative design is often characterised by the occurrence of a significant event, usually called the 'creative leap'" (Cross, 2001, p. 88-89). The creative leap is when a new idea seems to appear suddenly (Cross, 2001). The creative leap is the event that occurs which allows for the idea to take shape. It is that moment of opportunity recognized which sparks an idea. The problem in this thinking is that ideas do not just manifest out of nowhere. However, there are some critiques in this thinking that ideas occur suddenly.

According to Cross the creative leap "appears to be not so much taking a leap as building a bridge between problem requirements and solution proposal" (Cross, 2007, p. 66). The idea that seems to appear out of nowhere is a connection between what was done before and what they will do. When a new solution is considered to have appeared out of nowhere, rather than attributing this to the idea of a "creative leap" we can think of this as a connection. It is informed by what came before and leads to what comes next. This presents the concept that what came before (research) and what comes after (ideation) are two distinct phases but rather are connected by a bridge. We can consider the creative leap in comparison to the double diamond design process. The before is the first diamond, the after is the second diamond, while the creative leap is somewhere along where the two meet. Instead of the ideas being sudden, seemingly coming

from nowhere at all, they are informed by the work that has already been done, what the designers see in the world, or what experiences they have. Instead of the two diamonds being two separate sections of the design process, there is a connection between the two, however difficult to define and visualize.

Regarding the point that the "creative leap" is not a leap at all we can look at a study conducted by Kees Dorst and Nigel Cross (2001) in which they explored creativity related to the design process. They concluded that creative design involves, "…a period of exploration in which problem and solution spaces are evolving and are unstable until (temporarily) fixed by an emergent bridge which identifies a problem-solution pairing" (p. 435). In describing the results of their study in which they found that the nine participants all had the same idea. Furthering this, they determined that all participants believed that their own idea was unique to themselves. (Dorst and Cross, 2001) Dorst and Cross (2001) found it "…interesting that they all seemed to think that this was an original concept" when in fact they all had come to the same conclusion (p. 433). The unique idea was not a sudden manifestation of something that one sole person presented. Instead, the information that was presented to participants was used by each person in a similar way causing each person to develop the same concept. The "creative leap" was a manifestation of the given information.

This all seems to contradict the previous statement that research is forgotten. While the creative leap alone is not the focus of the research, a consideration might be that all of the work that occurred before the bridge, the creative leap, is the forgotten or bottled-away research that was previously mentioned. The creative leap is the bridge that connects that research through ideation into refinement. Maybe it is not forgotten but rather just bottled away, and is in some ways still referenced in ideation however more subtly than through direct insights.

Fixation

Nigel Cross calls designers opportunists, taking advantage of new ideas. He expands on the creative leap to define it as a bridge. But what happens when that new idea is not exactly right? When it is pursued beyond its limits? This is might be related to fixation.

In *Design Knowing and Learning*, Nigel Cross writes that there is another form of fixation in which designers form an "attachment to early solution ideas and concepts." (Cross, 2001, p. 86) He continues on to say that this attachment causes the designer "to hang on to their principal solution concept for as long as possible" even as problems arise that would point to flaws in said concept (Cross, 2001, p. 86-87).

This fixation can stem from a number of situations. Cross cites, "Purcell and Gero therefore concluded that the industrial designers seem to be 'fixated on being different', and that 'fixation' in design may exist in a number of forms" (as cited in Cross, 2001, p. 86). The idea that a design must be new and innovative, or different, can be strong. It is often forgotten that innovation can exist in the new application of an old idea or in rethinking the way a problem-solution is looked at. Instead, the focus of innovation becomes the idea of being different both visually and otherwise.

When such a visually different idea is generated one can become fixated on it, continually iterating on that solution in order to not have to let go. "Even when severe problems are encountered, a considerable effort is made to make the initial idea work, rather than to stand back and adopt a fresh point of departure" (Rowe, 1998, p. 36). This is, of course, only one example of fixation, yet it is a common one especially with young designers.

Some of the various forms of fixation occur when a designer chooses only solutions that are different, innovative, and futuristic, or based on attachment to early solutions. This fixation

on ideas can be a means of exploring the problem or it can be a blinder, not allowing the designer to search further for ideas that better meet the needs of the user. When an idea occurs that is liked for one reason or another, one can become fixated on it, continually iterating on that solution in order to not have to let it go.

Synthesis

Synthesis, a significant step in the design process, occurring once the research is completed and analyzed is important understand synthesis because it plays a major role not only in the design process but also in this study.

In an article titled *Information Architecture and Design Strategy: The Importance of Synthesis during the Process of Design,* Jon Kolko (2007) writes, "The goal of design synthesis is to develop an understanding of the design opportunity that exists." (p. 1) In other words, in the synthesis phase of the design process, the designer attempts to "organize, manipulate, prune, and filter" the data after analysis and put it into a usable format to help guide the design process, ensuring the design criteria are based on the research conducted by the designer. (Kolko, 2007, p. 1) Kolko adds, "data synthesis requires a designer to forge connections between seemingly unrelated issues through a process of selective pruning and visual organization." (Kolko, 2007, p.1)

In another study, Jon Kolko (2009) says that synthesis is "an abductive sensemaking process" that can be described as being "the hypothesis that makes the most sense" based on the data collected by the designer (p. 19-20). He also says that "abduction is a logical way of considering inference or 'best guess' leaps" (Kolko, 2009, p. 20). In comparing abductive thinking to inductive and deductive thinking he says that abductive thinking presents the space to create "new knowledge" and to develop insights (Kolko, 2009, p.20).

So, what does this synthesis look like in the design process? In an ideal situation, Kolko describes it as an externalization of the data collected. (Kolko, 2007, p. 3) Because there is far too much data to retain and recall, it is externalized, almost always in the form of a wall, usually covered in photos, sticky notes, charts, mind maps, etc. Using this information an affinity chart is created. This means that the designer starts moving the pieces around, organizing the data into groups. This is when the connections in the data are being forged. These connections are used to create themes. These themes are then used to create the guiding principles, or the design criteria, of the design project (Kolko, 2007).

While the data is external, the connections are being forged internally. Kolko says that synthesis is often performed, "in the head" where it can seem or be invisible (Kolko, 2009, p. 15). He adds that when synthesis is conducted in this manner there is "no visisble connection between input and output" (kolko, 2009, p. 15) Even more fascinating is that "often, even the designers themselves are unable to articulate exactly why their design insights are valuable."

When it comes to clients this process, which appears invisible, can be thought of as happening "magically" when even the designer is unable to articulate the importance of the insights they developed. Because of this it can be difficult to accept the process as anything but "magical" or "coming out of nowhere" (Kolko, 2009, p. 15).

In reference to the wall, Kolko says, "ironically, Designers will frequently spend a great deal of time creating a war-room style wall of data, organization and pinning the material up, and then ignore is for the remainder of the project." (Kolko, 2007, p. 3) However, he also notes that once the affinity chart is created and the designer has drawn conclusions from the information, the wall becomes unnecessary. This suggests that with proper synthesis the wall becomes unnecessary, it assumes that proper synthesis has been done. This is now always the case.

Even more important to note is that even when synthesis is not done correctly, or even not done at all, the wall of information still gets ignored. For synthesis to work you need data to begin with, lots of data. If you don't collect enough at the start and don't collect more as you go, you have nothing to synthesize. Another common problem in the synthesis phase, noted by Kolko, is that of anxiety relating to the wall of data. (Kolko, 2007, p.3) While this study doesn't focus on anxiety in the design process, it is important to understand that this can contribute to a lack of synthesis. There are a variety of other problems within the research and synthesis phases of the design process which contribute to a breakdown of synthesis. Some of these are discussed in this study, though there are likely many more not considered.

In summary, synthesis is an important phase of the design process referring to organizing data collected, building connections in the data, and creating criteria from which to design. It is completed through a process of abductive thinking which can make synthesis appear "magical". However, this process of synthesis is integral to ensuring a design process which successfully bases a design on user research that is conducted. Unfortunately, a proper synthesis does not always occur, setting up the rest of the design process for problems.

Conclusion

Nigel Cross (2001) said that fixation can occur in the form of hanging onto ones first idea even when encountering problems arise suggesting that it might not be the best solution. While usually ideation occurs after synthesis with the ideas being based on the insights developed through that process, fixation can disrupt that process. At this point the idea begins to impact the data collected, the synthesis process, and the ideation process.

Jon Kolko (2009) says synthesis can seem "magical" and Nigel Cross (2007) says that the creative leap can seem like a "sudden illumination" almost as if it too were magical or the two

processes were to “come out of nowhere”. However, we learn from Jon Kolko (2009) that synthesis is actually a process of abductive thinking and while it is might be invisible to the viewer, a process occurs to move from data to insights. In addition, we learn from Nigel Cross (2007) that rather than the creative leap occurring suddenly, it is more of a bridge that takes place. In some ways these two processes are connected through this abductive thinking. Both occur behind the scenes, invisible to the viewer. Yet complex processes are occurring which allows the designer to arrive from data to insights to ideation. The creative leap (Cross, 2007) is the bridge between synthesis and ideation.

In the world of design research, a gap exists. Much of the research focuses on smaller or more specific events within the design process. Though those events often impact projects both on small and large scales, there are not many studies that use direct observation for an extended period of time to observe the design process from start to finish. Because much of the existing research is focused on specific problems occurring, rather than what is happening to research throughout the design process over time, there lies the gap. This is where this research comes in.

The research question is broad. However, this allows for what happens to research (conducted by the designer) throughout the design process. This then begins to fill that gap by taking a broader view of the design process rather than looking at specific problems on their own to understand them better.

CHAPTER 3

METHODS

Through this empirical research we begin to explore the question of what happens to the research a designer conducts throughout the design process and what factors impact the effectiveness and the usefulness of that research. Because of this the research question is addressed is rather broad. For this reason, a broad approach is taken to research the problem. The approach is to observe students in the classroom for the duration of one project, conduct reflection interviews, to code the data collected, and from that develop themes which can be used to discuss events, opportunities, and differences in design processes. It is important to use empirical research to explore the research question because not only is it a broad question but requires observing the entire design process from start to finish. Through that direct observation of a project from start to finish, the problem can be explored from start to finish more thoroughly.

This study is an exploration of the factors that impact the various phases of the design process. It is not based on a measure of success of each students' work regarding grades because grading was in no way a part of the process observed or data collected. Rather the actual process of each student is explored in order to determine factors impacting the phases of the design process.

The method chosen to study the design process is direct observation. This is defined by H. Russell Bernard in Research Methods in Anthropology, "watching people and recording their behavior on the spot" (Bernard, 2011, p. 306). Direct observation allows for variety in data collected. It lets the researcher collect data that may not be available in a quantitative study. It

lets the researcher supplement purely qualitative data with numbers, if they so choose. It lets the researcher become deeply involved with those they are observing. This is important for this study because rather than looking at one specific phenomenon, the goal is to take a more broad approach, looking at the design process as a whole.

As the observer, my role was to observe and record what I see while being in a unique position of being familiar with the design process methods through having the experience of participating in such design work in the past. This study was conducted mainly through observation, with little interference in the process of the students so as not to alter the progression and outcomes of the project contributing to the project in any capacity. This meant not offering opinions on the projects even when students asked for them and not asking leading questions which might guide them towards a decision, potentially one they may not have chosen to make on their own.

This method was chosen in order to observe the design process from start to finish in real time. This method also allows for collecting various types of data over that longer period of time creating the ability to study specific points in the process, the process as a whole, and to make comparisons throughout the entire process. With the purpose of the study being to step back and take a look at the design process as a whole in order to see the connection of research to ideation throughout the various stages of the process, observation as a method of study meets that need.

The types of data collected through observation are field notes on actions, behaviors, social interactions, and work completed as well as photographs and digital files of work completed by students. Taking photographs of the work throughout the process is done in order to fill in gaps that might exist in the field notes or to help explain what is happening at a specific time with a visual representation.

The semester included multiple project. All students in the class were observed for the first project. This was done for two reasons. The first was to be able to get used to being in the classroom. This allowed the students to get used to me being around so that I would be less of a distraction to them and it would be more natural for me to be there. The second reason was to be able to observe the students in order to choose who to observe for project 2, the one that was used to collect data for this research. There were 18 students in the class and 4 were chosen to observe. Along with the instructor, the group observed for project 2 was chosen based on who would be most open to having me observe them and would also successfully complete the projects.

Once all of the data is compiled it is analyzed. The chosen method of analysis is coding, using the grounded theory method (Bernard, 2011, p. 435). Bernard describes grounded theory as having three steps which are, "coding the texts for themes; linking themes into theoretical models; and displaying and validating the models" (Bernard, 2011, p.435). This process begins by going through all of the field notes to find common and obvious themes. The next stage is to complete memoing. To do this the researcher reads through the field notes in a more in-depth manor while writing notes. In other words, the researcher writes field notes on their observations of the field notes. (Bernard, 2011) This is done to pick up on themes that are not immediately obvious and to fill in potential gaps. At that point the researcher looks for negative cases. These are cases "that don't fit the pattern" (Bernard, 2011, p. 435). Bernard adds, "Negative cases either disconfirm parts of a model or suggest new connections that need to be made" (Bernard, 2011, p. 435). All of this will be done to be able to develop themes. The themes that are developed through coding will be used to analyze the process of each design student in a more in-depth manor.

The process began with evaluating the field notes which were written during the observations. First all of the field notes were reviewed following class. After the observations were completed, the field notes were typed and then reviewed. Prior to coding, the notes were analyzed with important parts highlighted with notes made. This was done a second time to ensure that the same information was highlights as important. At this point the field notes were transferred into spreadsheet in order to expand on them, the memoing stage of the process (Bernard, 2011). After memoing was completed, key words were chosen for each of the points at which point a chart was created to organize all of the information into categories. This was done to see connections between the data and develop the themes that are written about and discussed here.

Following the observation portion, a follow-up interview was conducted. The students observed were asked to reflect upon their own design process, the project as a whole, what they felt was successful or not successful, and questions about the research they did. This was done to compare their own perception of the project to the observations conducted.

In addition to the code, or themes, each students design process was outlined from start to finish. This will be a visual representation of the design processes in order to compare differences in the processes as a whole. The charts of each students design process can then be compared and used to understand how different students interpret and implement the design process differently while also using the guidelines set by the instructor as a base comparison. By combining the code, the intended design process (as outlined by the instructor at the beginning of the project), and the design process chart created for each participant, the process can be viewed as a whole and piece by piece, allowing for analysis and comparison on multiple levels.

At the start of the research an assumption made was that the design process used in the class was the right design process and that deviation from that would be considered a flaw in the process of that student. In addition, it was initially assumed that students would follow the design process as outlined by the instructor though this proved to be incorrect. Rather students placed more emphasis on certain parts of the project based on their strengths while minimizing or eliminating other parts of the project based on their weaknesses. This is discussed in further detail in the discussion section.

It was also assumed that common problems noted by previous related research would be present. These would be problems or events such as fixation and the creative leap. Fixation was certainly a present theme.

The basis of the research, the assumption that students conduct research entirely separately from ideation and/or design, forgetting or leaving behind that research once they reach the idea generation stage, is predicted as a problem that exists, though it is not the only problem in connecting research to ideation. This study would then seek out patterns of research throughout the process, concentrating on a connection with research to elaborate on the idea that research does not connect to ideation in the way that is expected of students.

Students all learn differently. This has been noted in education research and documented such as by the theory of multiple intelligences. (Gardner, 2006) While this study does not include such a theory or research it in the context of design, it can be assumed that if students learn differently, they might also learn the design process differently and therefore implement or progress through the design process differently, based on those strengths and weaknesses.

CHAPTER 4

RESULTS

Project Description

The project handout given to students said that students were to “design a household equipment that promotes healthy habits”. Students were to initials work in teams of 3 or 4 to choose an overall theme, then breaking up into two smaller groups. Each individual/group of two were then asked to “design one product that fits the overall theme”. In addition, these concepts were to “be considered part of a larger system of products and or service”.

The students were asked to begin with “contextual research and interviews with a wide group of people” to discover habits. They were then asked to create journey maps, a tool to visualize research collected in from a user group. Using this they were to identify habits and pain points which were then to be used as design opportunities. Moving on from there students were to conduct market research. After this they were to develop “a set of product objectives and more specific design criteria” to guide the concept development within their smaller groups of two or individual designs.

At this point they were to break up into their smaller groups to generate ideas, refine, complete user testing, develop a final solution, build a full scale model, and then create a process book and presentation.

Early in the project students were allowed to choose to work individually rather than in groups of two. Because of that, the team observed included two people working individually and two working together. Not only was the group structure changed but the team theme was as well.

Instead of having one theme for the entire team, each individual/group of two chose unrelated themes. Therefore the end results was not a system of products.

As with the start of the project, many of these requirements changed as the project progressed. Students conducted a smaller number of interviews than expected, did not complete journey maps in groups or individually, and broke up into their smaller groups prior to having clear themes, objectives, or criteria. These changes are not all bad. Some are in response to student requests, adapting to the needs of the class in order to have a project that is as useful as it can be for each student.

Project Timeline

Figure 2: Project Timeline for Healthy Habits Project shows the original timeline of the Healthy Habits Project as it was presented to the students at the start of the project. The timeline includes what was due at the start of each class and what they were to begin working on in class each given day. This timeline is given for reference and to compare to each participants process. It is clear when comparing the intended timeline to the actual unfolding of events for each student that they do not line

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INTENDED PROJECT TIMELINE WITH PHASE OF DESIGN PROCESS MAPPED OUT

PHASE										
DATE	9/19	9/21	9/26	9/28	10/3	10/5	10/10	10/12	10/14	
GOAL	5W+H, mind mapping, journey mapping	Pin up: initial problem statement, research questions, 4 journey maps	Pin up: 8 journey maps, preliminary insights, insights from user research, identified habits, design opportunities End of class: refine design opportunities, define design objectives and criteria	Ideation sketches	Pin up: final concept idea, 2D study sketch, 3D model	Process book draft due, refined use scenarios, test model (end of class)	Appearance model done at 50%, process book draft, presentation draft, 2D detail drawing	Process book, presentation rehearsal, model at 90%	Short presentation, process book, appearance model	Extended deadline

Discover
Define
Develop
Deliver

Figure 2. *Project Timeline for Healthy Habits Project – This chart is a timeline based on the project description document and timeline given to the students in the observed course at the start of the project. It is color coded to show which stage of the process students were expected to be on any given day.*

In addition, the chart shows the phase in which students are expected to be in on any given day. These phase are based on the Double Diamond Process (Service Design Vancouver, 2014) and are shown through color coding each day. The original timeline of the project was to begin on September 19 and end on October 14. However, as the project progressed, the instructor determined it would be of benefit to the students to extend the deadline from October 14 to October 17.

Each of the following charts show the same timeline as in Figure 2 with the addition of each students own design process. Specifically, the phase in which each student was working in on any given day is shown in comparison to the original, intended timeline given to the students

by the instructor. The timelines of each student were determined based on two factors. The first being the actual work the student was completing on each day. For example, if a student was sketching for the class session, that would fall into the ideation stage of the process. Along with considering the work students completed, those themes present on each day were also evaluated to make sure that both the work and themes were in alignment to inform how the day was shown on the timeline chart.

It can be seen in the figures that some students had a much more linear process than others. In addition, the "define" phase was skipped for two students. Some students spent more time in ideation, others more time in research. This mismatch in the students processes is important because it shows that each student is understanding, processing, and implementing the stages of the process in different ways.

In Figure 3: Eric's Project Timeline as Compared to the Intended Timeline we can see how Eric's design process differed greatly from the intended timeline of the project. He spent the intended amount of time on research ("discover") with the addition of one day later in the process in which he backtracked into research again part way through ideation ("develop"). He skipped the "define" stage entirely in favor of ideation. This continued well into the intended time for the "deliver" stage in which ideation and "deliver" occurred simultaneously.

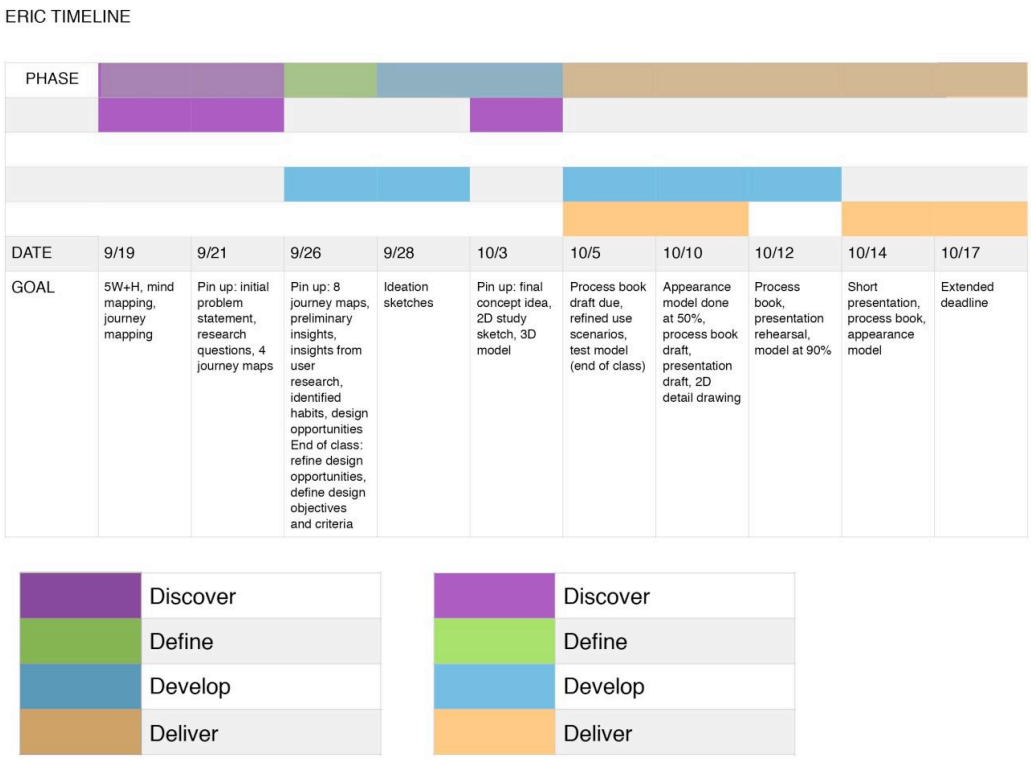


Figure 3. *Eric's Project Timeline as compared to the Intended Timeline – This timeline is based on the project description and timeline given to the students in the observed course at the start of the project. It is color coded to show which stage of the process students were expected to be on any given day. In addition, it shows the timeline of Eric's design process, charted based on field notes and the coding process. The muted colors are the original, intended timeline while the brighter colors shows the timeline of the student.*

In Figure 4: George and Ryan's Project Timeline as Compared to the Intended Timeline we can see George and Ryan's design process. For the most part their process followed the intended timeline. They spent the minimum amount of time on each phase as intended with the exception of the "deliver" phase. In addition to spending the intended amount of time on the first three phases of the design process and intended timeline, they circled back to spend an extra day (or two) on each of the first three phases during times of the project in which this made sense for

their goals. The extra time spent on each phase took place simultaneously because they often switched between phases as it made sense for the project. Also important to note is that they spent a considerable amount of time in the "define" phase, including an addition two days than originally intended.

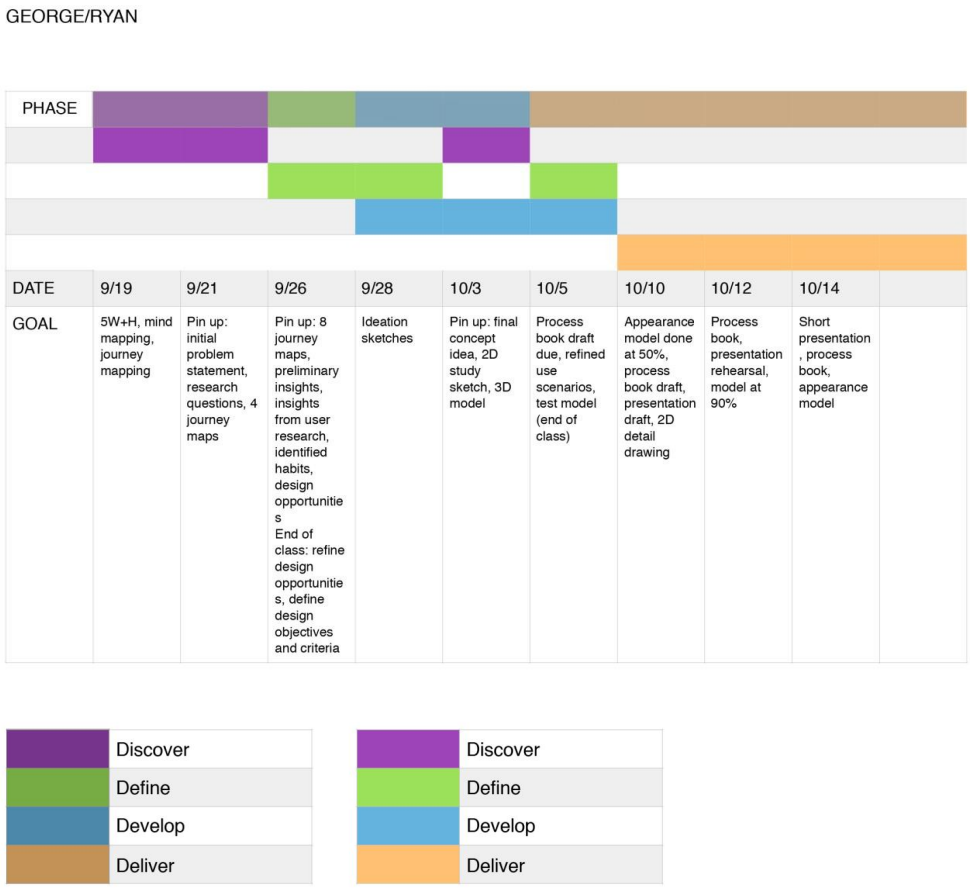


Figure 4. *George and Ryan's Project Timeline as Compared to the Intended Timeline – This timeline is based on the project description and timeline given to the students at the start of the project. It is color coded to show which stage of the process students were expected to be on any given day. In addition, it shows the timeline of George and Ryan's design process, charted based on field notes and the coding process. The muted colors are the original, intended timeline while the brighter colors shows the timeline of the student.*

In Figure 5: Blake's Project Timeline as Compared to the Intended Timeline we can see that Blake's process is much more linear than that of Eric and George and Ryan's processes. He spent an extra day on "discover" and "develop" while spending one less day than intended on "deliver" and skipped "define altogether.

BLAKE

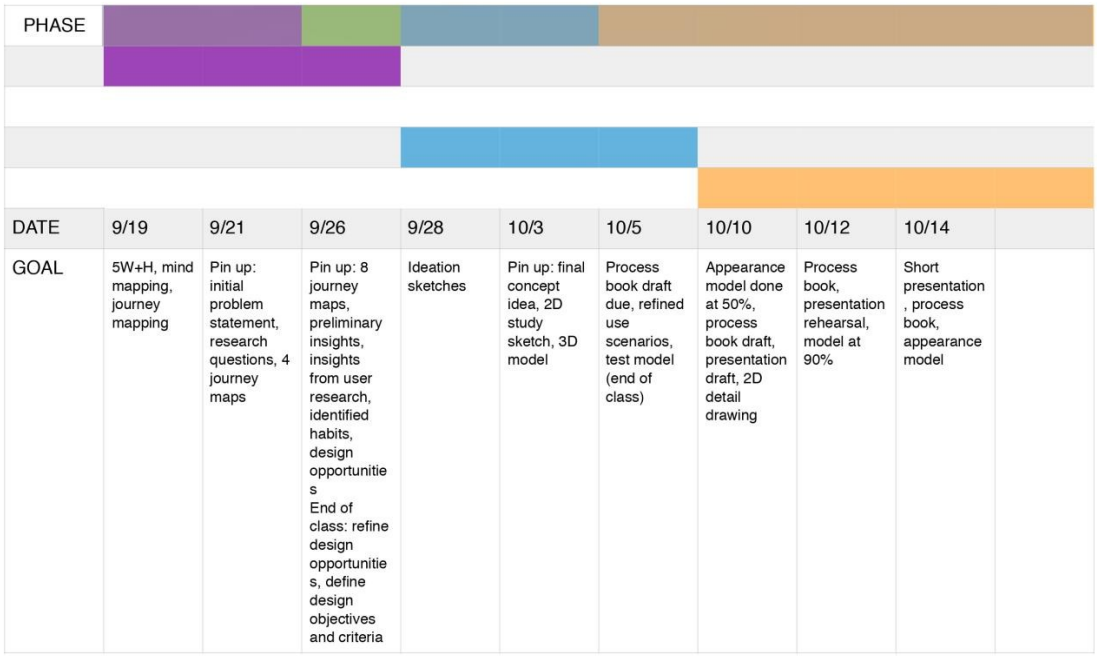


Figure 5. *Blake's Project Timeline as Compared to the Intended Timeline – This timeline is based on the project description and timeline given to the students in the observed course at the start of the project. It is color coded to show which stage of the process students were expected to be on any given day. In addition, it shows the timeline of Blake's design process, charted based on field notes and the coding process. The muted colors are the original, intended timeline while the brighter colors shows the timeline of the student.*

Theme Description

Table 1. *Themes, Codes, and Definitions- This chart shows each theme developed (from the field notes), the associated code, and a description. Note that Procrastination has no definition because it is combined with Avoidance.*

Theme	Code	Definition
Procrastination	PR	
Avoidance	AV	Either temporarily avoiding and skipping a task or stage of the process entirely. This theme is usually also directly connected to procrastination.
Emotion	EM	Some designers were impacted by emotions which generally contributed to procrastination and avoidance.
Fixation	FX	"Purcell and Gero therefore concluded that the industrial designers seem to be 'fixated on being different', and that 'fixation' in design may exist in a number of forms." (as cited in Cross, 2001, p. 86).
Feedback	FE	Feedback is generally any sort of comments that impacted their design process. Impacts were both positive and negative.
Research	RE	Research refers to many aspects of the process, however as a theme, it is specifically referring to when a designer let the research guide them through the design process or when the opposite occurred. It also is discussed when connected to other themes such as procrastination and avoidance.
Analysis	AN	Analysis refers to the stage of the process where student are to examine their data. This then leads into synthesis.
No Synthesis	NS	Here synthesis refers to the stage in the process after research and analysis has been conducted where students combine information and develop their guiding points of information.
Confused/Difficulty	CD	This refers to points in time when students were confused about the work to be completed or had difficulty understanding assigned tasks.

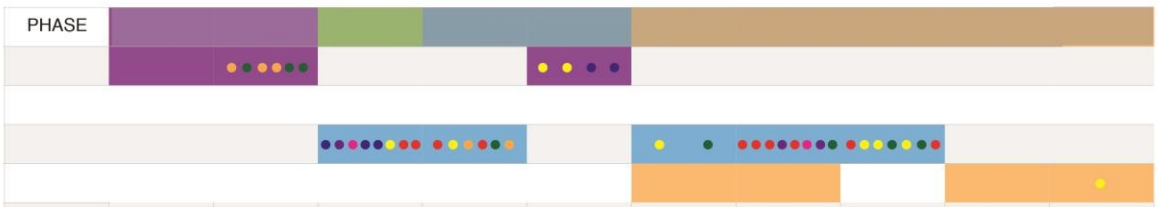
Project Timeline with Themes

Below in Figure's 7, 8, and 9. These are the same timelines are in Figures 3, 4, and 5 with the addition of color coded circles which show the presence of the various themes on any given day. These are based on the themes developed and focused on in this study.

Fixation (FX)= orange
Feedback (FE)= green
Research (RE)= blue
Confused/Did not Understand (CD)= purple
Analysis-Research (AN-RE)= pink
Emotion (EM)= yellow
Procrastination-Avoidance (PR-AV)=red
Synthesis (SY)= brown
Avoidance (AV)= maroon
Research-N (RE-N)= pale blue
No synthesis (NS)= light brown

Figure 6. *Color Code Chart- This charts shows the color coding system used to describe each theme in the following charts showing each students timeline with the themes added*

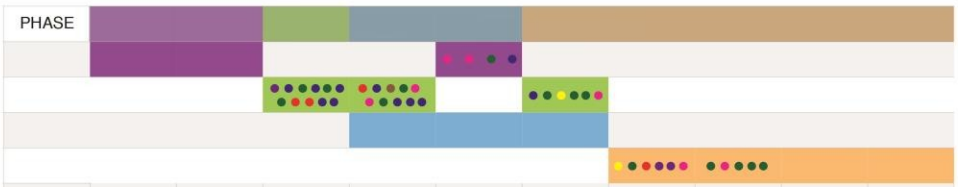
ERIC TIMELINE



DATE	9/19	9/21	9/26	9/28	10/3	10/5	10/10	10/12	10/14	10/17
GOAL	5W+H, mind mapping, journey mapping	Pin up: initial problem statement, research questions, 4 journey maps	Pin up: 8 journey maps, preliminary insights, insights from user research, identified habits, design opportunities End of class: refine design opportunities, define design objectives and criteria	Ideation sketches	Pin up: final concept idea, 2D study sketch, 3D model	Process book draft due, refined use scenarios, test model (end of class)	Appearance model done at 50%, process book draft, presentation draft, 2D detail drawing	Process book, presentation rehearsal, model at 90%	Short presentation, process book, appearance model	Extended deadline

Figure 7. *Eric's Project Timeline with Themes- Shows Eric's timeline with the themes added to show what themes were occurring throughout his design process*

GEORGE/RYAN



DATE	9/19	9/21	9/26	9/28	10/3	10/5	10/10	10/12	10/14
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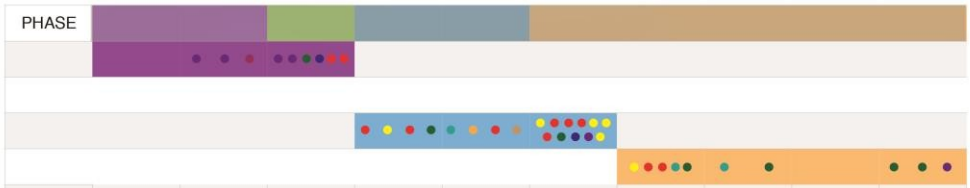
Figure 8. *George and Ryan's Project Timeline with Themes- Shows George and Ryan's timeline with the themes added to show what themes were occurring throughout his design process*

BLAKE



DATE	9/19	9/21	9/26	9/28	10/3	10/5	10/10	10/12	10/14
GOAL	5W+H, mind mapping, journey mapping	Pin up: initial problem statement, research questions, 4 journey maps	Pin up: 8 journey maps, preliminary insights, insights from user research, identified habits, design opportunities End of class: refine design opportunities, define design objectives and criteria	Ideation sketches	Pin up: final concept idea, 2D study sketch, 3D model	Process book draft due, refined use scenarios, test model (end of class)	Appearance model done at 50%, process book draft, presentation draft, 2D detail drawing	Process book, presentation rehearsal, model at 90%	Short presentation, process book, appearance model

Figure 9. *Blake's Project Timeline with Themes- Shows Blake's timeline with the themes added to show what themes were occurring throughout his design process*

Theme Occurrences

Table 2. *Themes and Number of Occurrences- This table shows each theme, broken down by each student. In bold are the top three themes for each student. Also included in this chart are the number of occurrences for each theme as they took place in the reflection interviews.*

Theme Occurrences

NAME	THEME	CODE	OCCURANCES	OCCURANCES (Interview)	TOP THEMES
George/Ryan	Confused/Did not Understand	CD	3	2	
	Avoidance	AV	0	0	
	Feedback	**FE**	**14**	**16**	2
	Procrastination-Avoidance	PR-AV	3	0	
	Emotion	EM	2	1	
	Fixation	FX	0	0	
	Research	**RE**	**18**	**11**	1
	No Research	RE-N	0	0	
	Analysis	**AN**	**7**	**0**	3
	No Synthesis	NS	0	5	
	Synthesis	SY	1	0	
Eric	Confused/Did not Understand	CD	3	1	
	Avoidance	AV	0	1	
	Feedback	**FE**	**9**	**1**	2
	Procrastination-Avoidance	**PR-AV**	**10**	**1**	1
	Emotion	**EM**	**9**	**0**	3
	Fixation	FX	5	2	
	Research	RE	6	3	
	No Research	RE-N	1	0	
	Analysis	AN	2	0	
	No Synthesis	NS	0	2	
	Synthesis	SY	0	0	
Blake	**Confused/Did not Understand**	**CD**	**6**	**2**	2
	Avoidance	AV	2	0	
	Feedback	**FE**	**7**	**0**	3
	Procrastination-Avoidance	**PR-AV**	**10**	**2**	1
	Emotion	**EM**	**7**	**0**	3
	Fixation	FX	1	0	
	Research	RE	3	0	
	No Research	RE-N	3	0	
	Analysis	AN	0	0	
	No Synthesis	NS	1	0	
	Synthesis	SY	0	0	

Table 2 shows the themes, their number of occurrences, and the top three theme occurrences for the students observed. George and Ryan's top three themes are Research,

Feedback, and Analysis. Eric's top three themes are Procrastination-Avoidance, Feedback, and Emotion. Blake's top three themes are Procrastination-Avoidance, Confused/Did not Understand, and tied for third are Emotion and Feedback. The top themes are Eric and Blake are both similar, including the same themes. George and Ryan's themes include the theme of Research, which were not as present for Eric and Blake. This is representative of their design process as compared to Eric's and Blake's processes. George and Ryan's design processes relied heavily on research while Eric's, for example, relied more on ideation.

Student Work

Eric

The theme that Eric chose is laundry habits. He described his opportunity as "Designing a product that fits within the current laundry system and makes the entire process quicker and simpler." His objectives were to design a product that is easy to use, fits within the current system, is affordable, is stylistic, and is compact. His ideation method was through a random association method, further described in the discussion section. It is shown here in Figure 10: Research Page from Eric's Process Book. The following images come from the process book Eric created which was a required document each student was to submit at the end of the project. These documents are created as the project is nearing completion or is already completed. With that in mind, much of the work is considered and described (such as design objectives) upon reflection of their own work.

Figure 10. *Research Page from Eric's Process Book- This figure shows a page from Eric's process book in which he summarized some of the research he conducted. This was created after the project was nearly completed.*

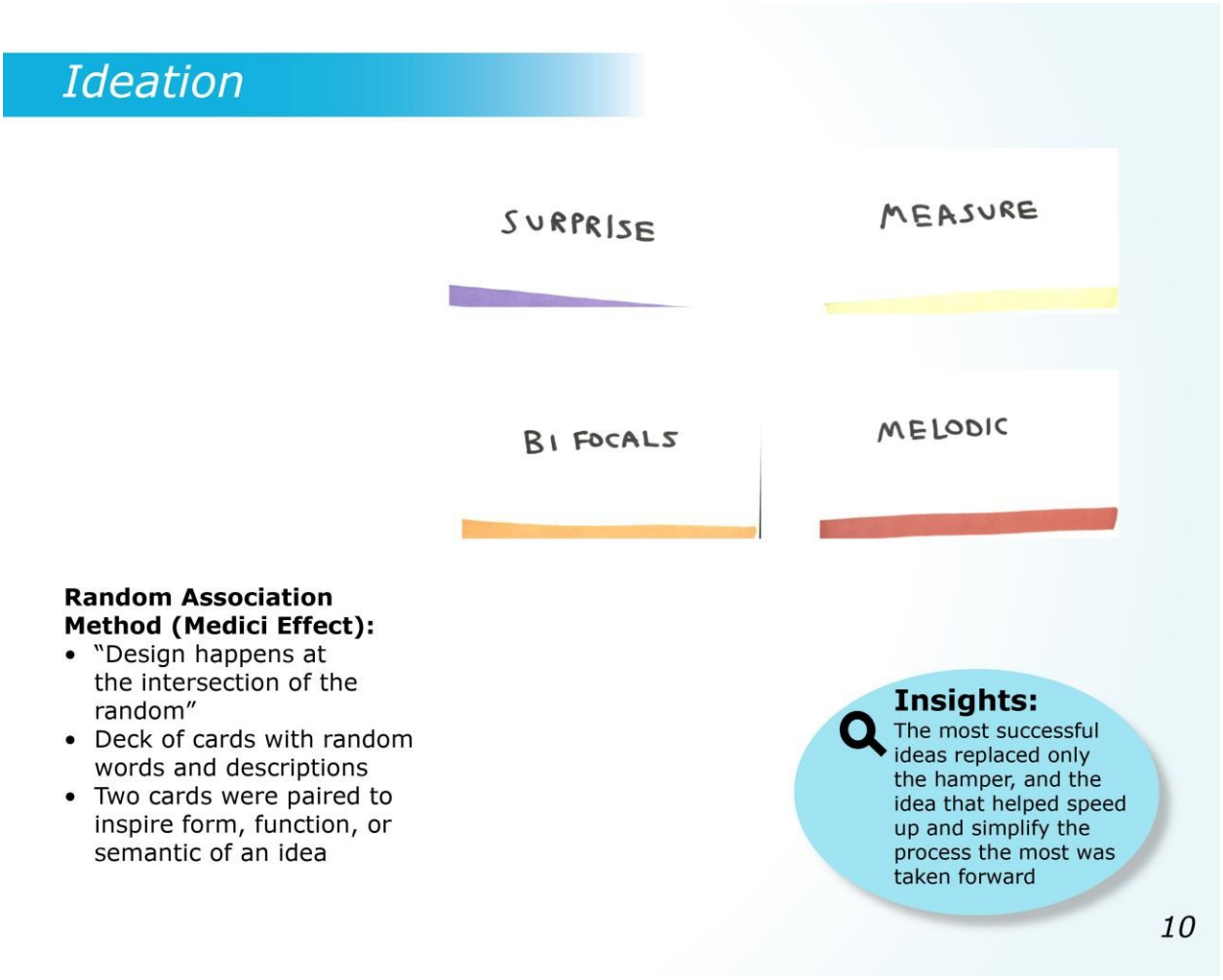


Figure 11. *Ideation Method Page from Eric's Process Book- This figure shows a page from Eric's process book in which he summarized some of the ideation method that he used.*

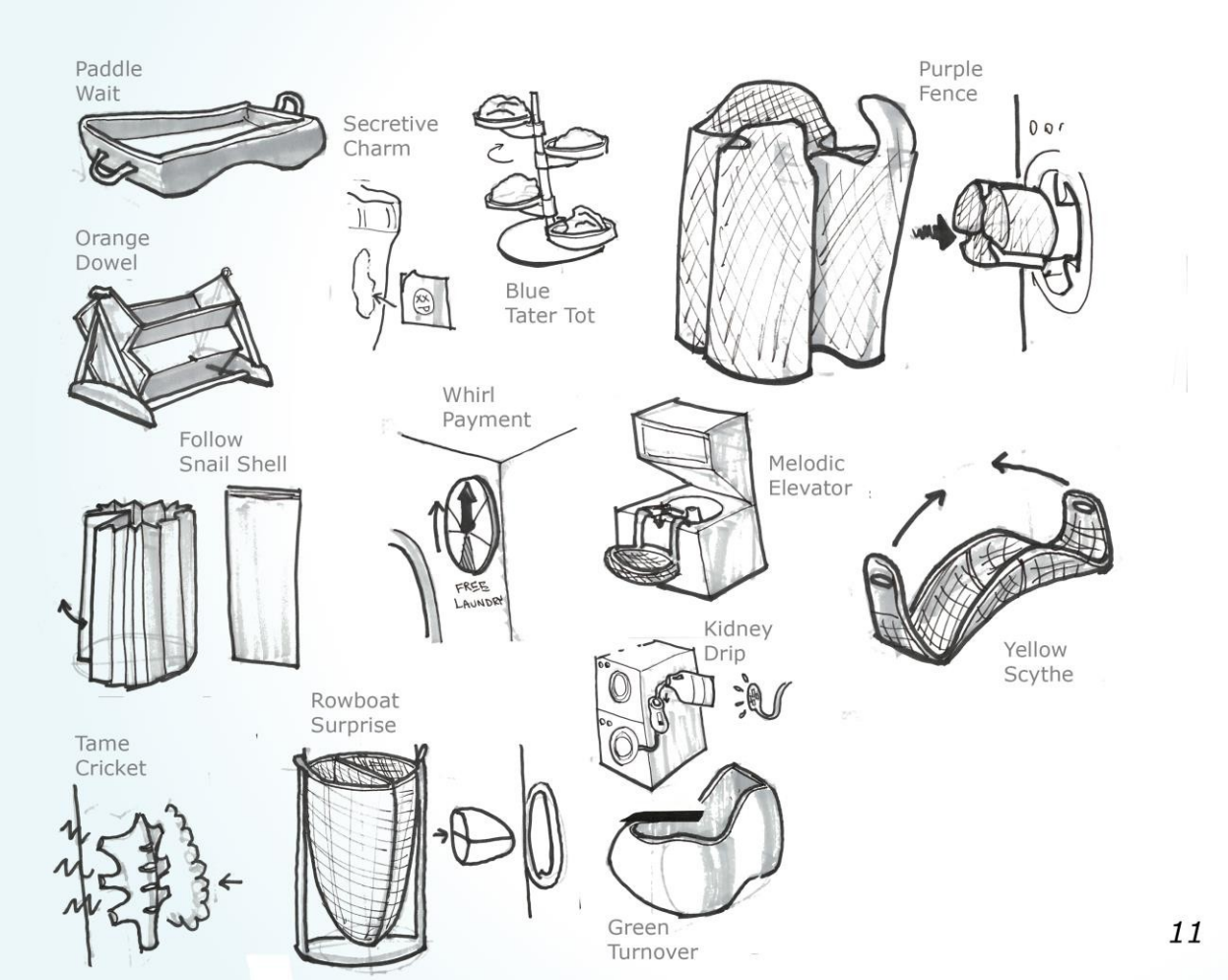


Figure 12. *Sketching Examples Page from Eric's Process Book- This figure shows a page from Eric's process book in which he showed some of his sketches that he created as a part of the project.*

Figure 13. *Final Design Page from Eric's Process Book- This figure shows a page from Eric's process book in which he showed his final design.*

George and Ryan

George and Ryan chose smoking as the habit they wanted to design for. Their opportunity was framed as a question: "In what ways can trending technology be used to motivate millennial smokers to move towards quitting?" This opportunity was developed after a number of iterations. Changes were made as more research data was collected, guiding them towards the final opportunity statement that they developed. They had a number of criteria. (see Figure 14: Objective and Criteria Page from George and Ryan's Process Book) After conducting market research they determined that wearable technology was to be the type of product they

design. Their ideation process was guided mainly by their research. They also discussed their concepts with their user group for feedback before making design decisions. Their ideation process included both 2D and 3D techniques. (See Figure 16: 2D and 3D Design Page from George and Ryan's Process Book) Below are images showing parts of their process. These are taken from the process book they created.

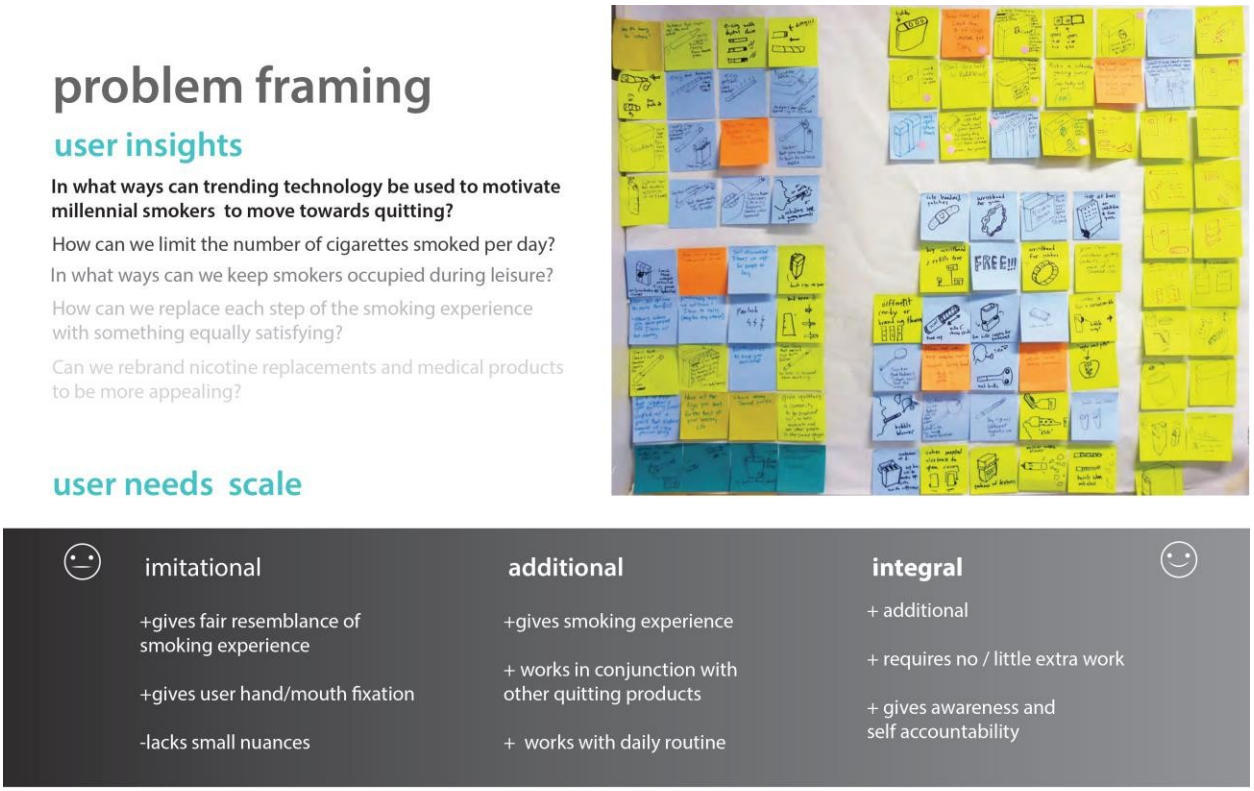


Figure 14. *Objective and Criteria Page from George and Ryan's Process Book- This figure shows a page from George and Ryan's process book in which they showed their objectives and criteria.*

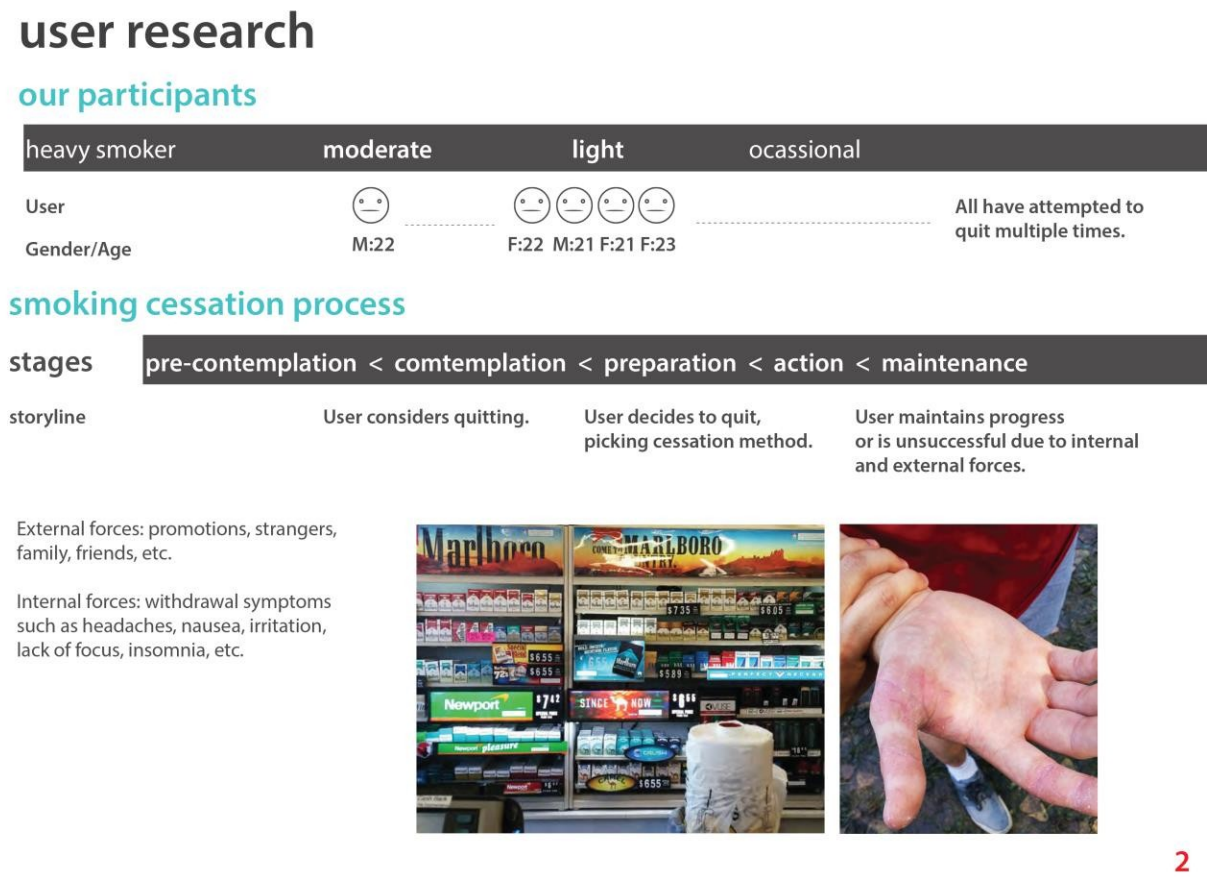


Figure 15. *User Research Page from George and Ryan's Process Book- This figure shows a page from George and Ryan's process book in which they showed data from their user research.*

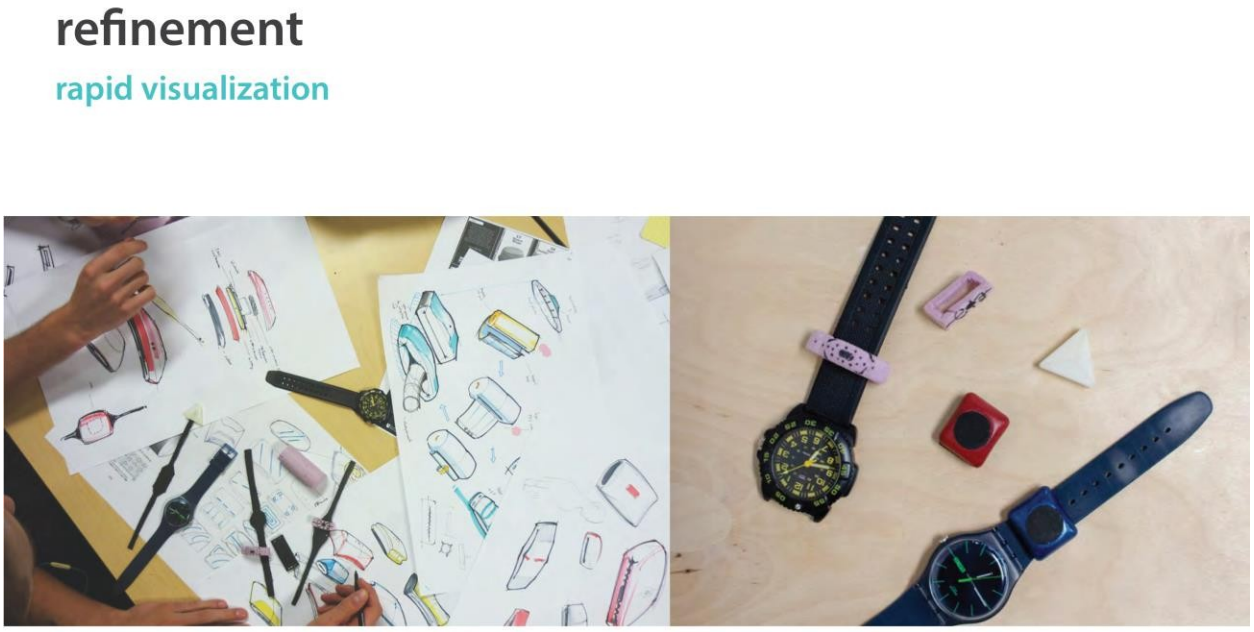


Figure 16. *2D and 3D Design Page from George and Ryan's Process Book- This figure shows a page from George and Ryan's process book in which they showed some of their 2D and 3D design work including sketches, foam models, and 3D printed models.*

Figure 17. *Final Design Page from George and Ryan's Process Book- This figure shows a page from George and Ryan's process book in which they showed their final design. It is a device which attaches to a fitness tracker or watch that aids in the process of quitting smoking.*

Blake

Blake chose storage as a theme. He had a number of opportunities (Figure 18: Opportunities Page from Blake's Process Book) which he summed up into one question: "How can a product motivate to keep bedroom spaces clutter-free?" His research revolved around a mind map which he created after completing two interviews. For ideation he used a variation of the LOTUS method. Below are images from his process book.

Figure 18. *Opportunities Page from Blake's Process Book- This figure shows a page from Blake's process book in which he showed the opportunity questions he developed during the project including the ones that led to the final one he chose.*

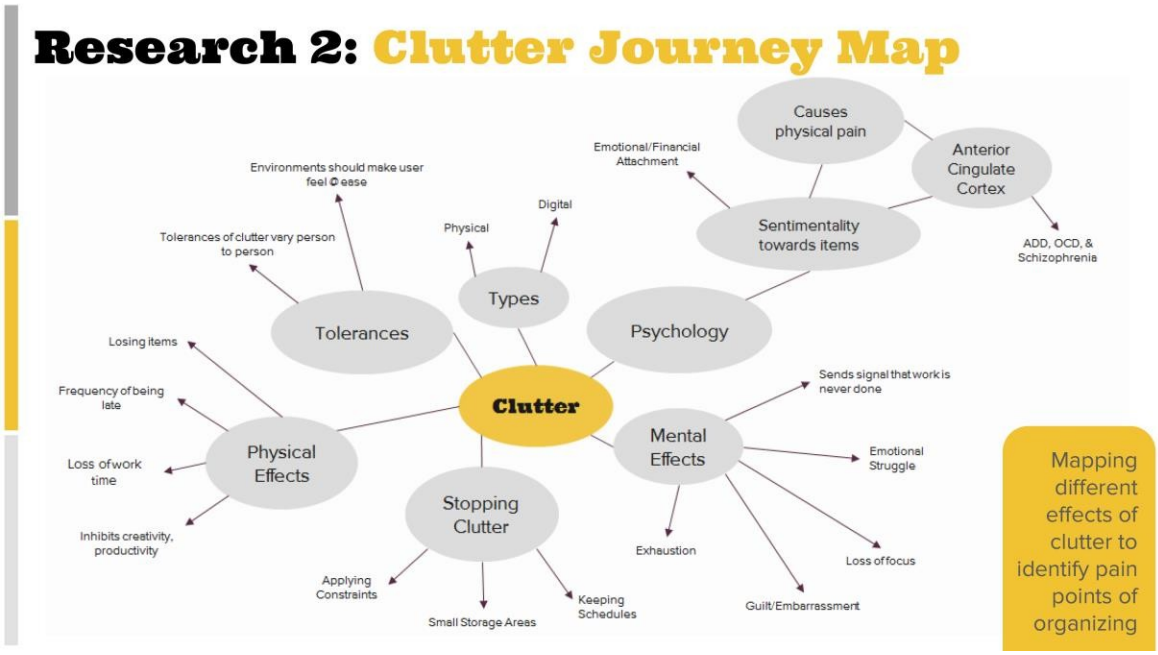


Figure 19. *Clutter Journey Map Page from Blake's Process Book- This figure shows a page from Blake's process book in which he shows the mind map he created (confused with a journey map).*

Figure 20. *Results and Insights Page from Blake's Process Book- This figure shows a page from Blake's process book in which he showed his results and insights, though developed after the project was nearly completed.*

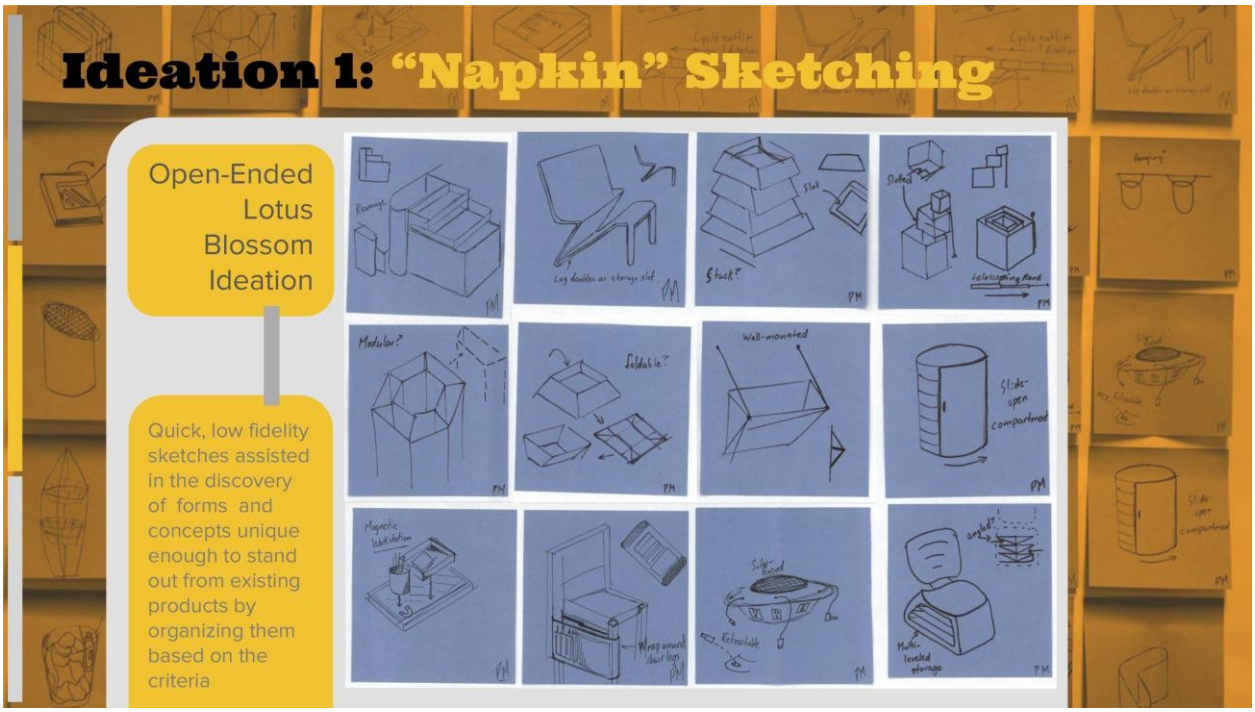


Figure 21. *Ideation Page from Blake's Process Book- This figure shows a page from Blake's process book in which he showed his ideation process using the Lotus Blossom method.*

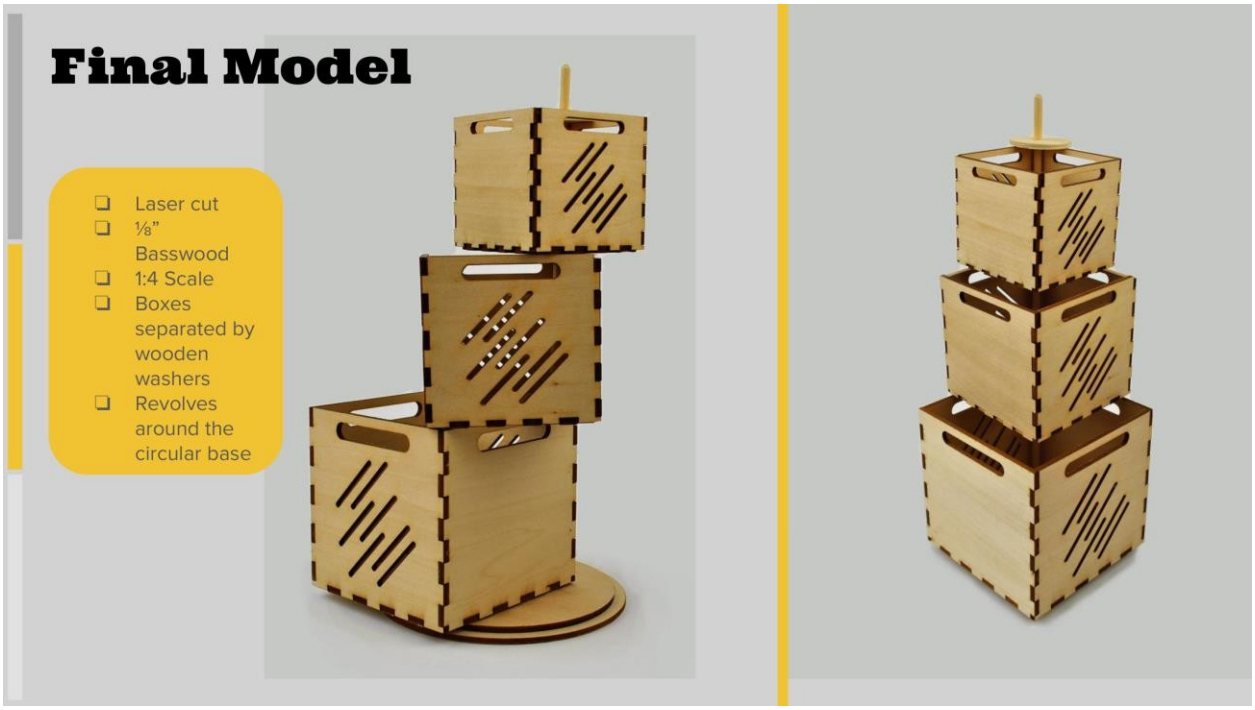


Figure 22. *Final Design Page from Blake's Process Book- This figure shows a page from Blake's process book in which he showed his final design.*

CHAPTER 5

DISCUSSION

Themes

A theme can be defined as one distinct and recurring subject, principle, or idea. In this study, themes were developed from the field notes through a coding process. These themes are used to discuss what is happening in the design process. The themes often connect with each other and impact each other. They are presented individually and, when necessary, discussed in connection with each other, using examples of students work and processes to understand the themes and sub-themes.

These identified themes are presented individually as well as in connection with other themes and regarding the impacts on the design process and the students own work. Examples of students work will be used to demonstrate the impact on their own work and design processes.

Fixation

Fixation is an attachment to an idea. Nigel Cross (2007) says about fixation that even though "…designers change goals and constraints as they design, they appear to hang on to their principal solution concept for as long as possible, even when detailed development of the scheme throws up unexpected difficulties and shortcomings in the solutions…" (p. 105). Fixation can be a major source of problems within the design process such as when a person develops their research to make their idea stand out, influences a lack of research, and fixing the idea repeatedly to make it work even when it doesn't truly solve the problem. Fixation is not always so serious that it will lead to failure. It can have minor effects as well, such as less thorough research or

spending too much time on one idea. Fixation alone does not, however, define the success of a product. Many more factors go into the success or failure of a product.

Eric

An example of Eric's design process will be discussed here as it relates to Nigel Cross's fixation theory (2007). Eric began his design process with interviews, as did all students. During the second class day of the project he mentioned an idea relating to the laundry basket and the task of doing laundry. In the reflection interview after the project he mentioned having this idea originally occur during the interviews he conducted at the beginning of the project.

Fixation and Research

The Designing for Healthy Habits project began with exploring the problem of habits. (Students were asked to complete mind maps, journey maps, develop potential research questions, identify potential problems, and conduct interviews. At this point the research methods used by each student would vary based on the problems they identified. However, they were asked to continue with user and market research. Here we will be discussing Eric's research process which began with two interviews, an intended cultural probe, and a survey. Also discussed is Eric's early ideation as it relates to the research.

Early on, immediately following the two interviews Eric conducted, he began discussing an idea he had. He first said he was certain that he wanted to pursue laundry habits. From there he began to describe his idea which innovates the idea of the laundry basket, making the process of transferring the laundry from basket to washer to dryer easier. Eric's laundry basket idea was related to a breakdown of his research process. Because this idea was developed within the first few days of the project, at least a week before ideation was to begin, and re-emerged at various

times throughout the design process, leading to the final solution, this is considered as the idea that he becomes fixated on.

His research process is important to discuss here because it was impacted by his early idea of making the use of a laundry basket easier. Students were asked to continue conducting more interviews in order to create their journey maps. Eric had already selected his topic at this point. He spoke with the instructor who suggested he send out cultural probes. A cultural probe usually consists of putting together a set of tasks for a person to conduct and document. It might ask them to take photographs, draw something, answer questions, or to complete other similar tasks. It is "a way of gathering information about people and their activities" (Infodesign, 2012). In this case the idea suggested was to ask people to document their process of doing laundry through photographs.

When this was first suggested, Eric had an aversion to it. He mentioned not wanting to ask people to do this for him and that he thought that no one would really respond so it was not going to work. After some further discussion with the instructor, he decided to go ahead with the cultural probes.

In the next class meeting he showed up with one set of photographs (see Figure 23: Eric's Laundry Process Photos and Research Data Chart) of someone's laundry process. It was revealed soon after that the photographs were of himself doing his own laundry. Rather than asking others to collect data, he used himself to collect data due to not wanting to complete the task. The issue with using oneself for data collection is that this risks not solving the intended problem or the data might not apply to the larger population.

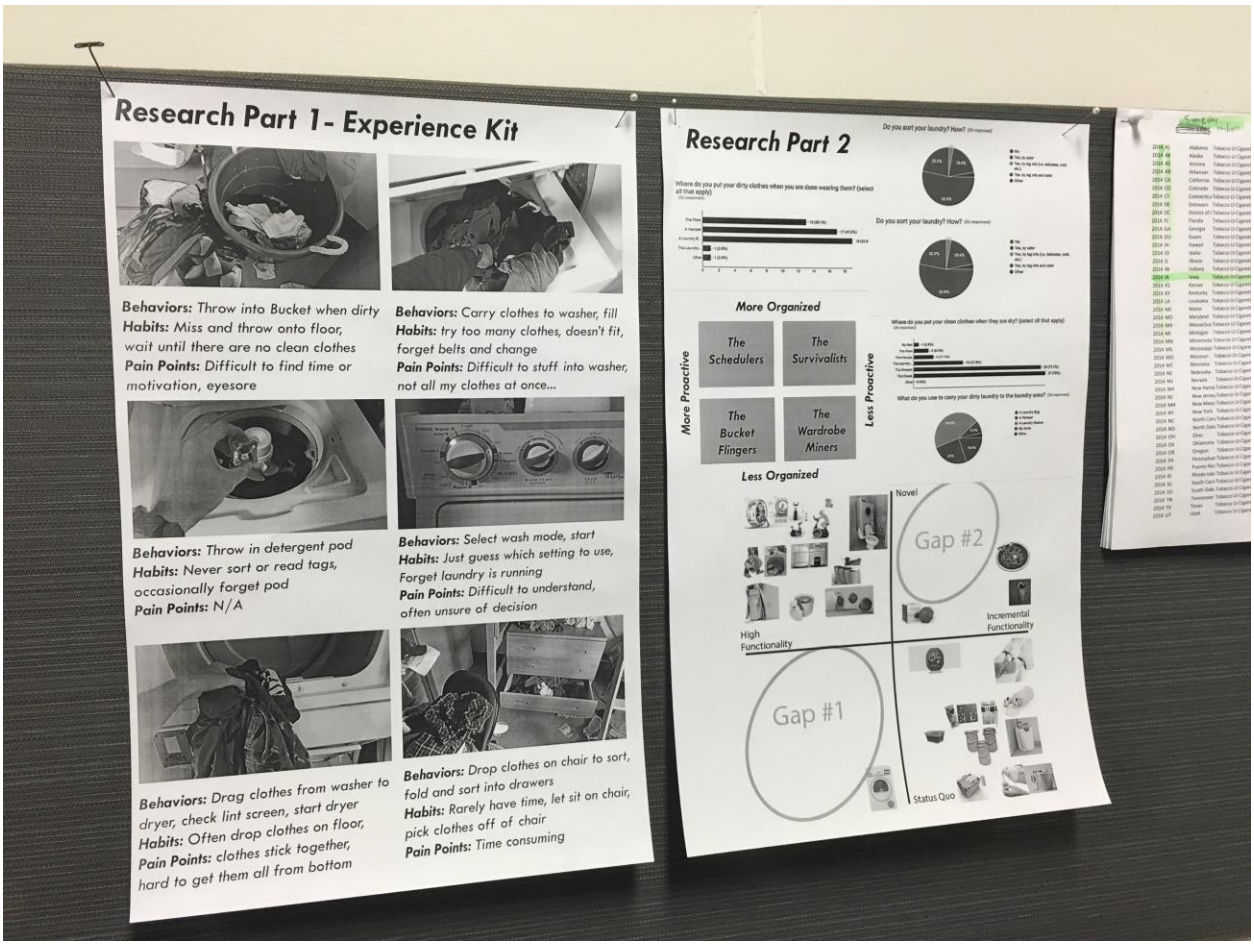


Figure 23. *Eric's Laundry Process Photos and Research Data Chart- This photo is of the documents Eric created to show the laundry process (called Experience Kit) and the rest of the research data he collected.*

At the same time as the cultural probe, Eric had a survey out to understand laundry habits further. As noted in the field notes, "Eric has a survey out to decide on which group (from his earlier poster of types of people/laundry) to focus on." In his process book he said that his survey included ten questions and 37 responses, with an age range of 18-25 for respondents. The survey occurred early in the project and was meant to continue exploring habits as a problem. However, his survey was about laundry habits and specifically the process of doing laundry. In a follow-up

interview, when asked about the survey, Eric said, “the survey wasn’t the most effective. I’d say the interview was.” Though he added that he could have done more interviews.

Fixation and Ideation (Negative Case)

It is difficult to say whether the ideation process was impacted greatly by the fixated idea. In the follow-up interview, when asked about the idea, Eric said he did not initially want to pick the idea because he felt that he was not supposed to choose one that came about in such a way but ultimately went with it anyways because they received some positive feedback on it. He did include the idea within his ideation process and received positive feedback on it from the instructor. In addition, during an interaction with the instructor, he remarked that he could easily “get married to” the idea.

While this is a good argument for saying that maybe fixation did not impact the process, there are some important questions to consider such as: How did the student present the idea? Did they describe it better than other ideas? Was more time spent on describing this idea as compared to other solutions? Were the drawings more detailed? More visually pleasing? When an idea that is liked more than another it might be presented better than other ideas to ensure that the viewer also chooses that one as the favorite even if it does not solve the problem entirely or maybe is not the best solution.

Fixation- Conclusion

Fixation as defined by Nigel Cross (2007) can be a part of the design process and can impact it. This same phenomenon occurred in Eric’s design process which impacted not only the course of the project but also the outcomes of the project. It should be noted that while fixation occurred, it was also tied in with other themes such as feedback so it alone is not the defining factor in the trajectory of Eric’s design process.

Procrastination and Avoidance

Another two themes that were present in the design process of the students observed are procrastination and avoidance. These two themes had an impact on the design process, especially on the research conducted by the students. Though they are separate themes they often occur together. Because of this they are discussed together, along with examples of students work. Procrastination and avoidance can simply be described as either temporarily avoiding work or skipping it altogether. Oftentimes procrastination and avoidance are a direct result of something outside the scope of the research. (Ex. A student is too busy with other tasks outside of class and runs out of time to complete something.) That said, it is still discussed because the impact on the design process are often noticeable.

Here we will discuss a more general example of procrastination and avoidance that was common among each student as well as a more specific example. The first discussed is journey maps, which were supposed to be completed at the beginning of the project. The other example that will be discussed is the previously mentioned one in which Eric avoided completing a cultural probe and then instead used himself as a participant to collect data from. It is discussed more in depth here.

Journey Maps

Journey maps, a tool to visualize research collected in from a user group. In journey maps topics presented might be behaviors, emotions, schedules, etc. They were assigned at the beginning of the project. Students were asked to create multiple journey maps in an effort to explore habits further. Unfortunately, not one true journey map was created by any of the students observed. It is unclear what the reasons that journey maps were avoided is. However, they were avoided entirely even though interviews were conducted. Interview information was

kept in the question-answer format that the data was recorded in. (See Figure 24. Interview Data from Observed Students for an example). The process stopped short there.

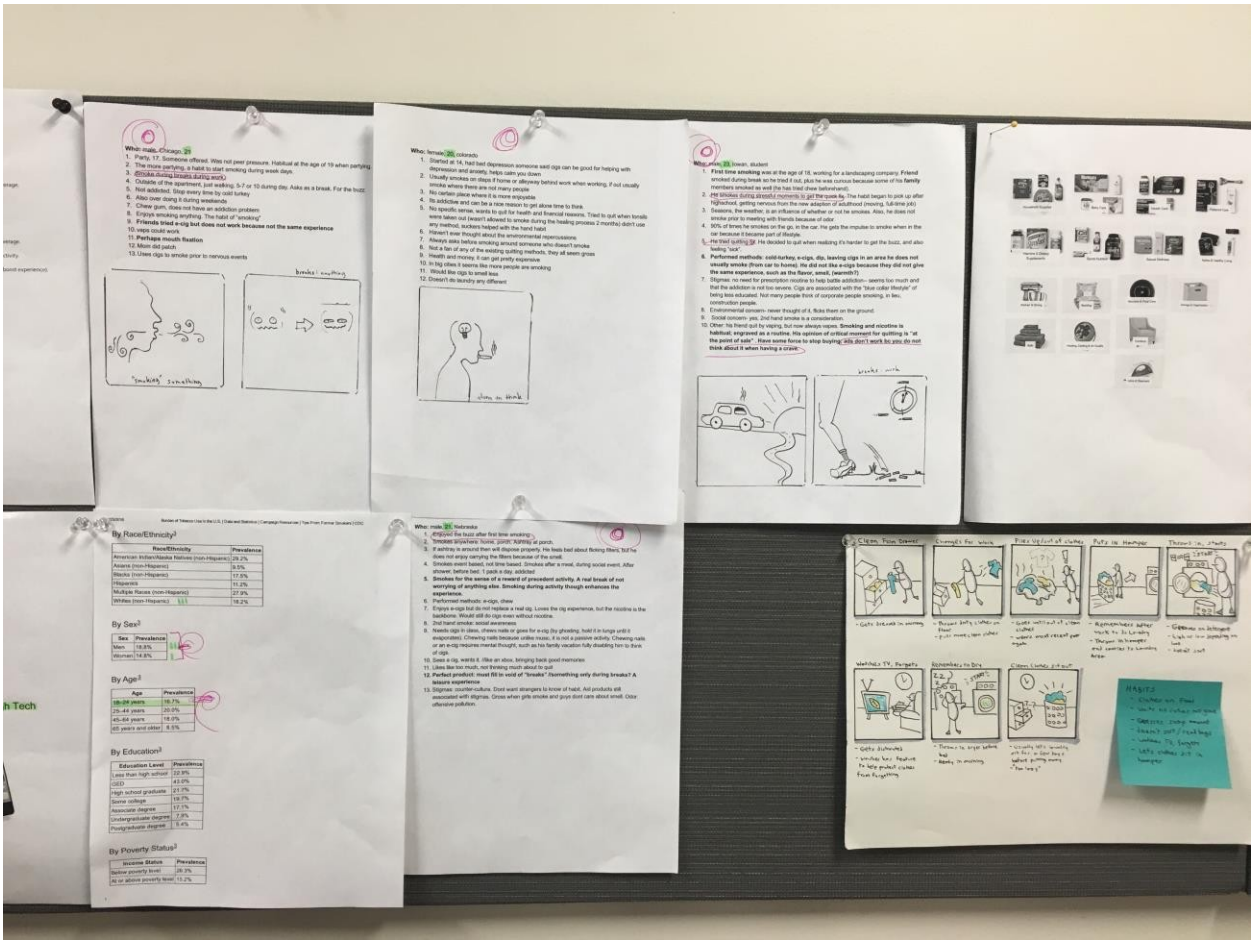


Figure 24. *Interview Data from Observed Students- This photo is of the interview data collected by George and Ryan as well as other research data such as a story board created by Eric.*

The impact of not translating the interview data into a visual representation within the journey map is that the information becomes easily lost or inaccessible. The data becomes more easily overlooked during analysis and synthesis, leaving open the potential for the data not to be included at all. Journey maps will be further discussed in the next section as there were other factors which had an impact on journey maps not being completed.

Cultural Probe

The second example discussed here is the step in the process immediately following the interviews and journey maps. After the interviews, during a discussion with the instructor in which she gave feedback on the data Eric collected he was asked to complete a cultural probe. He was told to ask people to take photographs of their own laundry processes and provide them with a questionnaire to answer in order to collect more data. At this suggestion Eric seems to have an aversion to asking people to take photographs of their laundry process.

He did briefly seem to be open to the idea, taking a phone call from one of the previous people he had interviewed, during which he left the classroom in order to ask a few more questions of them. However, by the next class he had made the decision not to complete the cultural probe. Instead he showed up with photographs of only his own laundry process. (See Figure 23) This is not an unheard of issue, unfortunately, so it is important to mention. It became easier for him to collect this data from himself, avoiding the task of asking other people to do the same.

The issue with collecting data in this manner is that the data becomes about only your own perceptions potentially leading to you designing for yourself rather than for others. This then becomes a self-centered design process rather than a human-centered design process in which you are designing for others.

Procrastination and Avoidance- Conclusion

These are just two examples of procrastination and avoidance. They do not scratch the surface of this issue. However, the reasons for procrastination and avoidance were not in the scope of the project. Rather, they are discussed in order to recognize that they do impact the research conducted as a part of the design process.

Confused or Did Not Understand

A problem which appeared at various times throughout the design process not only with the individuals directly observed but noted by the instructor during a formal discussions with the class, is that students often don't understand specific terms (analysis and synthesis, for example) and therefor implement them incorrectly or not at all. In addition, there are times when students might understand how to complete two different tasks but have the titles confused, therefore they might complete the wrong task.

Journey Maps

One example of this is when journey maps were not completed. This was in part due to procrastination and avoidance, as previously mentioned. There is also the potential the some students were confused about what journey maps are or how to create them. Though it should be noted that all students completed journey maps in the previous project so they were aware of what they are.

The example discussed here comes from Blake. After Blake had completed his interviews, he developed what was a mind map. He included various bits of information that came from the interviews. He then labeled it a journey map. (See Figure 25: Clutter Journey Map Created by Blake). The purpose of journey maps and mind maps are very different. A mind map allows you to build and see connections between various ideas (Litemind, 2017) while a journey map lets you explore a specific user or user group (Temkin, 2010) in order to determine potential problems in a process. In this project, they would be used to determine habits.

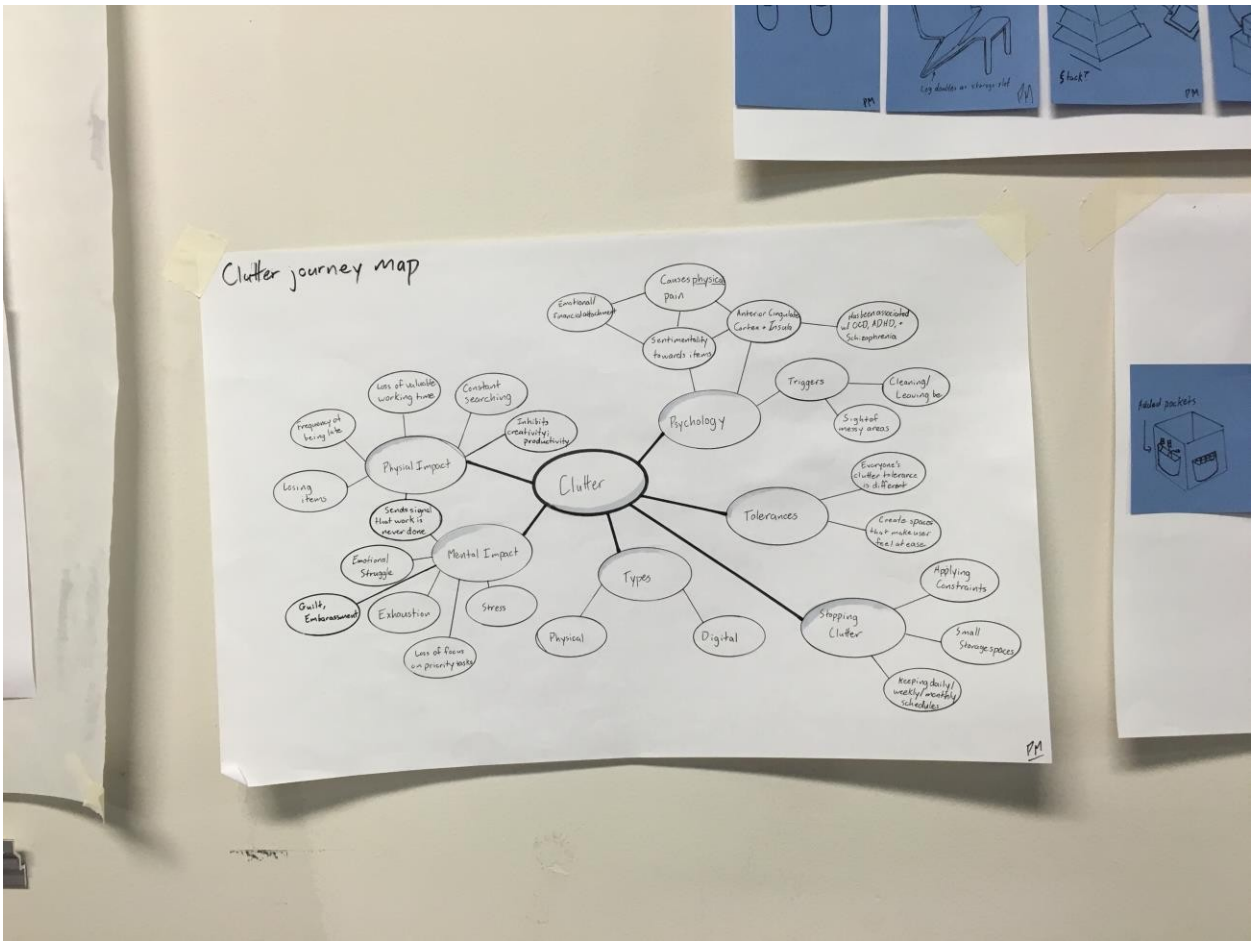


Figure 25. *Clutter Journey Map Created by Blake- This photo is of the map created by Blake, labeled "Clutter Journey Map".*

Because Blake did not complete a journey map but rather completed a mind map, he was unable to find clear habits. This became a major stumbling block throughout his design process, holding up the progress of his project at times.

Analysis and Synthesis

The issue of students not understanding what they were asked to completed occurred at other times of the process such as when it was noted by the instructor that students were not using the terms analysis and synthesis correctly, sometimes confusing the terms or considering

them to have the same definition. While this was presented as a problem to the students by the instructor there was not a clear solution.

There are a variety of reasons why students might confused terms or tasks or not understand them altogether. Some of these might be that they have not been taught how to complete a task, they might not have completed the task before, they might not have ever heard of the tasks or terms before, among other reasons.

While it is important for students to become independent in the design process, learning how to seek out information for themselves in order to develop their own ideas, it can be problematic to ask them to complete tasks without ever being taught the process or purpose of those tasks.

Much of the confusion of terms occurred during the research phase. This could mean that research was not completed as thoroughly or correctly as possible. Confusion and misunderstanding could then be a major factor in the lack of connection between user research and idea generation. This lack of connection between the two contributed to problems in the rest of the process. When the research is not thoroughly or correctly completed there is too much room for error or even ignoring the research altogether.

The problem with a lack of connection between the two phases is that the final design then risks not solving the problem the designer originally intended to solve. It may even solve a problem that didn't exist. Another potential situation is that it might solve what the designer thinks is a problem but is not the true problem. Not having accurate research, along with accurate analysis and synthesis of the research, risks the entire success of the product.

Research

Research as a theme is rather broad but it has connections to many other parts of the design process. Research is impacted by other themes as well. This project began with research. Specifically students were asked to start interviewing people to create journey maps and then find habits within that which they were to use as a jumping off point for their designs.

Beginning with the journey maps, which is discussed in a more in-depth manor in the previous sections, we see that from the beginning the research process was off to a slow start. The students observed conducted very few interviews. Though they were to use those interviews to develop their journey maps, these were not completed at all. In terms of research and ability to use the research to develop their problem statements, they didn't have much to go off of. Having little research to base this on led to students having difficulty in creating and further developing the problem statements they were asked to create.

George and Ryan's Research Process

On a positive note, research guided the design process of some students. George and Ryan often took in the information they were receiving and used it to determine what they needed to further research in order to have a better design outcome. We can look at their design process to see how they used research in order to achieve their goal of changing the habit of smoking.

One example of research guiding decisions in George and Ryan's design process is when they were in the later parts of the ideation phase. At this point they knew they wanted to create a device which would provide some sort of feedback to the user about their smoking habits as a part of changing that habit. They did market research to determine what kinds of products people use to track information. They found that popular today are fitness trackers. They then used this

information to make a decision to create a wearable technology which would track the users smoking habits.

George and Ryan's design process heavily relied on research. They often conducted their work as in the above example in which they had a question that fit within their problem statement, would research the answer, and then would use that information in order to move forward in their design process. For them, this method of progressing forward through research was successful. It led them to a successful design which received positive feedback from both their instructor and their peers in the final review.

They recognized that their process relied heavily on research and commented on how they realized they could show their entire decision-making process based on the research they had done throughout the project. They were excited that they had the information to back up the claims and decisions they made throughout their process. Theirs is a great example of how to successfully use research throughout the design process.

Based on this back-and-forth process in which they would ask a question related to the work they were doing, would research it, and then make decisions based on that research, they had a research-focused design process. This is in contrast to the design process of Eric, for example, in which he had an ideation-focused design process.

Eric's Research Process

Eric started out with research, as did everyone else in the class. He completed interviews at the beginning of the project. He used himself to collect information on how people do their laundry. He conducted one survey to ask questions about doing laundry. Later in the process, he did complete some market research. Though he didn't take photographs of this process. He very quickly moved on to the ideation process, leaving behind the research.

Throughout his ideation process he used laundry habits as his starting point, not visibly referencing any research. Moving forward from there, Eric used his ideation methods as a guide. This is in contrast to George and Ryan's design process which relied heavily on research. This is not to say that relying on research is better or always the correct method. Instead, this points to the idea that the design process can be successfully guided by information other than research. In this case, ideation propelled the design process forward rather than research.

Synthesis

When looking at synthesis in the context of the study, we can look at examples of some students work to understand synthesis within the scope of the study.

Case 1: George and Ryan

Beginning the discussion of synthesis, we look to the team of two, George and Ryan, who conducted the most research. The synthesis process begins with having physical representations of all the data collected, generally pinned onto a wall so that it can all be seen at once. (Kolko, 2007) The organization of research data can be important. George and Ryan had their research data pinned up. However, due to limited space, their research was placed in multiple locations on different walls. In synthesis, once you have a large collection of data, it can be overwhelming so you must "use basic visual design to begin to clean up the mess" (Kolko, 2007). We can see this would be difficult as the data was presented in multiple locations. This can make it difficult to make connections in the data, to categorize the information for the purposes of analysis and synthesis. (Kolko, 2007) (See Figure 26: George and Ryan's Research Data 1, Figure 27: George and Ryan's Research Data 2, and Figure 28: George and Ryan's Research Data 3 for reference of their research data and how they pinned up their data).

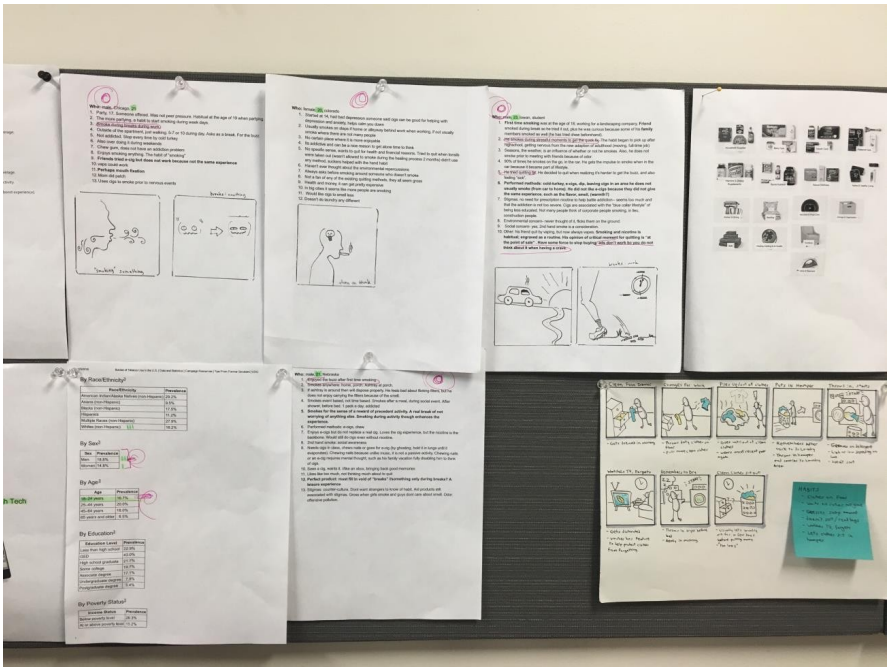


Figure 26. *George and Ryan's Research Data 1*

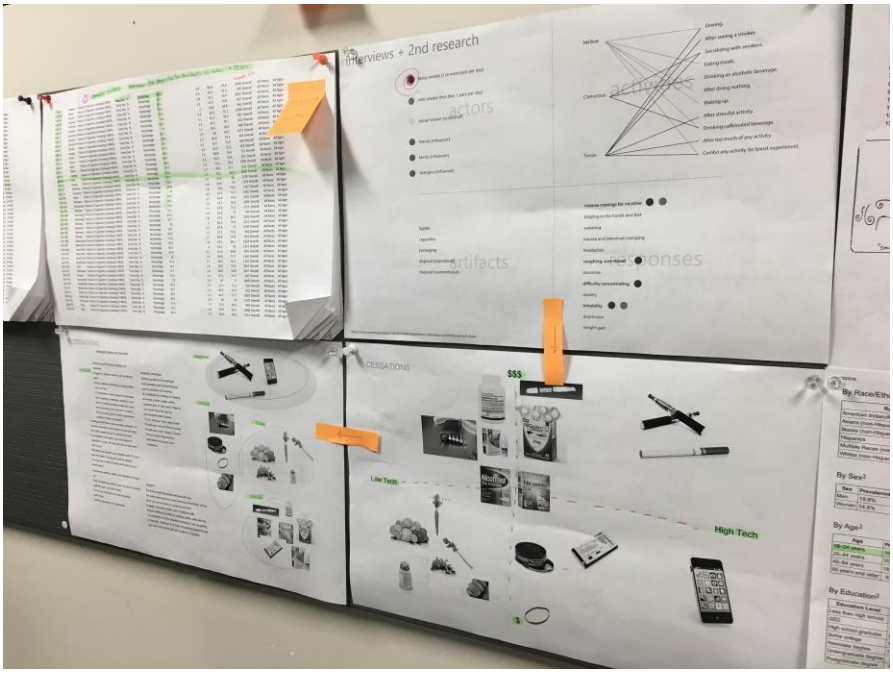


Figure 27. *George and Ryan's Research Data 2*

Figure 28. *George and Ryan's Research Data 3*

The presentation of data contributed to a lack of synthesis. Instead of being able to use the information they had to inform their design, they often had to collect more data for design guidance because they didn't have a clear set of guiding principles. In addition, during the reflection interviews they said, "…I think if we would have synthesized better we would have deviated from our final concepts…" When asked what research methods were least effective they said, "…maybe the way we synthesized research but I don't think we have been taught that so far" though they had gone over methods for synthesis in another course. They added that the

instructor, “helped synthesize the information” but later responded to another question saying that they, “didn’t have objectives until later on.”

Data collected by the students was often located in different areas of their work space. This did not allow them to fully synthesize the information. Not having synthesis be fully completed as a part of the process impacted the creation of objectives which they created later on. This is one example of what happens when synthesis is not completed.

Case 2: Eric

Overall Eric had less research data collected than George and Ryan. This alone had impacts on his ability to synthesize the data. His research, shown below, consists of a mind map based on interview which took place in the first week of the project, a chart labeled “Experience Kit” which depicted and described himself doing laundry (see Figure 23), another chart labeled “Research Part 2” which summarized his survey results, and a storyboard (see Figure 29: Eric’s Storyboard) created at the beginning of the project. Eric did visualize the data he collected to “clean up the mess” (Kolko, 2007) which was to his benefit because he could easily reference the data he collected.

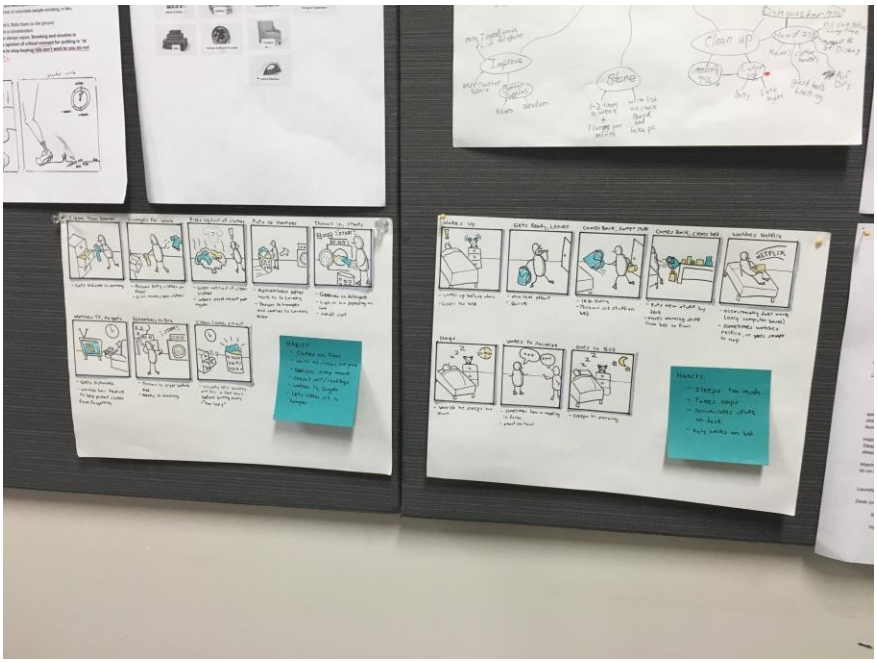


Figure 29. *Eric's Storyboard*

Case 3: Blake

We can also look at Blake's research and synthesis process. A major step in synthesis is to "externalize the data through a process of spatialization and reframing." (Kolko, 2007) Of note in Blake's process is a lack of externalization. He pinned up his research question, two mind maps, and some sketches on sticky notes. This could contribute to many potential issues in synthesis. What impacted synthesis most is that the data was not externalized. However, other factors can contribute to the data not being externalized. For example, it's possible that if there is not much pinned up on the wall, not much data was collected to begin with.

Ideation

Ideation methods were utilized to varying degrees by each student. For Eric, ideation was a major source of inspiration and moved the project forward. For George and Ryan, ideation was

guided by research. For Blake, ideation was difficult. Ideation can be a strong point or a point of struggle.

Case 1: Eric

While Eric struggled in the research phase of the design process he thrived in the ideation stage. He drew on his past experience to use as inspiration in the ideation method he used. He used a random association method to generate ideas. (See Figure 11). He used a random work generator to create a list of words. He wrote each word on a stack of notecards. He would then choose two cards. The two words he chose were then used as inspiration for sketching as many ideas as he could within a set time limit.

This method yielded many ideas with positive results. (See Figure 30: Eric's Sketches Resulting from his Ideation Process). He explored further than his original idea at the beginning of the project. Though it is important to note that he did end up choosing the original idea he had even after this ideation method. He did receive positive feedback on his ideation and on the original idea, which he did include in the sketches that he created.

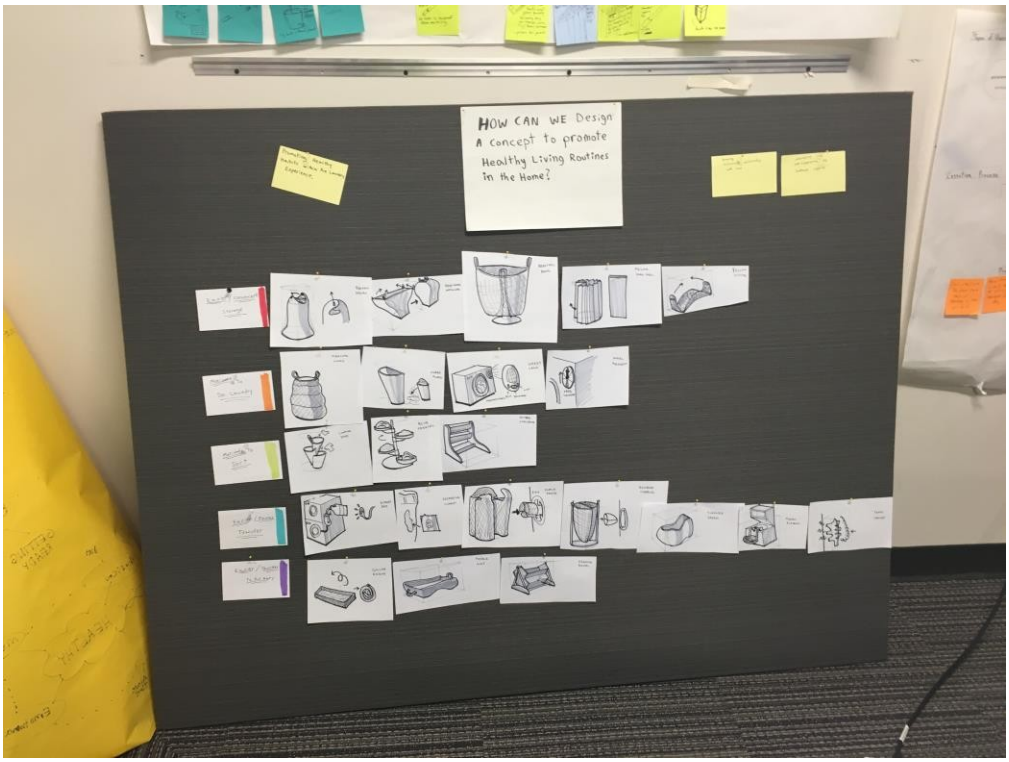


Figure 30. *Eric's Sketches Resulting from his Ideation Process*

Case 2: George and Ryan

George and Ryan had an ideation process that relied on continued research. While they had many sketches, they allowed the research they did to guide them through the process. This meant that as they had questions on form, they sought out information to help them make decisions. One example of this is the final direction of the project in which they decided to create a wearable technology that tracks the users smoking habits.

It was not originally a wearable device but after some market research they determined that fitness trackers are popular and that they could use this to help market their product. With that in mind, they went back to their research data which said that smokers did not always want people to know that they smoke. Using that information, they determined that their idea needed to be inconspicuous as to not call out the user as a smoker. By combining their continued

research on fitness trackers with their early research they were able to use that information to create a product that met the users' needs.

Case 3: Blake

Blake did not share a lot of his work. However, he did use some methods for ideation. He used the Lotus method and heuristics cards. The Lotus Blossom method is described by James M. Higgins as method in which the designer begin with one idea. Then surrounding that one idea are related ideas. These can continue expanding outwards until a suitable solution has been reached or until a large number of ideas have been developed (Higgins, 1996, p. 378). "Design Heuristics are prompts that facilitate and guide design space exploration during concept generation by helping designers initiate new ideas from scratch or transform existing ideas into new solutions" (Kotys-Schwarts, Daly, Yilmaz, Knight, & Polmear, 2014). The outcomes of his ideation methods were difficult to determine because he did not share much of his work.

Feedback

Feedback is an integral part of the design process. Feedback can confirm that what you are doing is heading in the right direction. Feedback can also change the course of a project, cause you to re-evaluate, or even to scrap an idea or direction altogether. Feedback can even prevent errors or redirect you. Feedback can also provide motivation to keep going on the project. Whether feedback is good or bad is not evaluated. Rather it is the occurrence of feedback and the impact on the project that is discussed.

Throughout the entire project, the instructor circulated the classroom, meeting with each group of students in order to discuss what they have been working on and to give feedback. Presented here is one example of feedback provided to George and Ryan which redirected their design, leading to their final design which was successful.

George and Ryan had an idea which built on an existing technology for smoking cessation that they found. When they presented this idea, the instructor did not have positive feedback for them. They were encouraged to explore other ideas even though they were excited about the idea they had.

By the next class they had developed a new direction for their design which would be focused on reducing the amount that people smoke, eventually to zero. The feedback they received from their instructor led them to seek other options to solve their problem. Once they had a new direction they were able to move forward with their design. Ultimately, this led to a successful outcome which received positive feedback in the final presentation from both their instructor and their peers.

Emotions

Emotions can play a role in the advancement and outcomes of a project. Positive emotions can help to propel one forward in the progress of the project while negative emotions can prevent one from completing their work, for example. Emotions played a role in the observed students though it was not as major of a contributor to the process as some of the other major themes.

Positive emotions are discussed first. George and Ryan, working on changing the habit of smoking, experienced confidence after their early exploration in research and design which led to a continued positive process. Their confidence may have contributed to their continued successes in which they were able to move forward in the project without many stumbling blocks. They received positive feedback and felt confident in their decisions, allowing them to focus on continued ideation and additional research as needed. This is in contrast to situations where negative emotions such as worry or even just having low energy led to a lack of work.

Eric, who was working on changing habits within the laundry process, experienced negative emotions. During the ideation phase is when much of this started. By this point in the project Eric spoke about having low energy and not being excited about the project so far. This often led to less productive work during in-class work times than he previously had. As the project moved forward, the emotions he commented on were nervousness and worry.

In the reflection interview Eric commented on the fear that he felt which impacted decisions he made during the project.

> "Most of it was fear. I didn't want somebody to say it's terrible for this reason and this reason and this reason…for me this is getting it done on time was technically worth $8000…" because of tuition "getting this project done was so dauntingly important that I probably skipped steps…there was a point where I was like I don't want to change anything because I don't feel like I could get it done in time."

Nervousness and worry often make an appearance as project deadlines begin to approach. This is nothing new for industrial designers. However, in this case he commented on these emotions which were occurring due to other factors such as when he was not yet able to start on his final model because he was waiting for feedback on the modeling methods he wanted to use. Many factors lead to worry, stress, nervousness, etc. in the design process. They don't always contribute to the trajectory of the project but can have an impact on the project in terms of amount of work completed or level of effort put into completing the work.

Conclusions

One conclusion made from the research is that there are many factors impacting the design process. Beyond this, the way a student designs varies from one student to another. This is similar to the Multiple Intelligences theory which is described as "a set of abilities, talents, or

mental skills." (Gardner, 2006 pg. 6) Gardner continues on saying that "individuals possess each of these skills to some extent; individuals differ in the degree of skill and in the nature of their combination." (Gardner, 2006 pg. 6) Gardner adds that "such a theory has important educational implications." (Gardner, 2006 pg. 6) The idea is that if students learn differently, if they have differing skills, might they also have different skills, or strengths, regarding the design process? This could then have an impact on which stages of the process are most successfully carried out.

For example, Eric had what could be considered a shorter research phase yet he flourished in the ideation phase. The two students who worked together, George and Ryan, focused heavily on research, relying on it throughout their process, constantly referencing their data and collecting more data as they needed to. In both instances their processes led to a successful outcome in the sense that they received positive feedback on their final designs from both their peers and their instructor.

The point being that as much as we expect students to follow through the design process in a single given manner, many factors impact whether this is right for the student or the project. Factors from emotions to knowledge of material and beyond influence how a student carries out their project. On the other side of this, it should be recognized that even the same project in the same class carried out by different students is potentially going to result in a different process. This is in part due to the students own strengths, likes, and dislikes but also may be impacted by the nature of the project. Some projects, which might have a more commonly understood focus, such as was the case with Eric who focused on laundry, may need less research than a project that is focusing on something less familiar and more complex, such as was the case with George and Ryan who focused on smoking. This essentially means that not only is the design process

influenced by factors coming from the student it may also be influenced by factors coming from the very nature of the project focus itself.

Another finding of the research opens the question of how we teach design. Oftentimes we expect that students know how to complete a given task, such as developing a problem statement. They are then asked to complete that task with little to no direction beyond being asked to write a problem statement. It is sometimes assumed that they have learned this in previous studios or in other courses when in reality not all students will have learned this at the early time in their education that this course takes place. This points out that not only must our expectations of what students know change but the way we approach assigning tasks must change.

Impact on Pedagogy

This research suggests that there is a connection between the design process, synthesis, and feedback to pedagogy. Specifically we can consider each of these alongside how design is taught. For example, while we understand that the design process is not linear we continue to describe it as linear (research>analysis and synthesis>ideation>refinement), structure projects as linear, and then continue on to teach it in the same way. However, this research shows that not only is the process non-linear but students do not all follow the process in the same manner. With this in mind, maybe it is time to reconsider how the design process is planned and taught to reflect the non-linear nature of the design process.

Synthesis is connected to pedagogy as well in that it is an area of opportunity when it comes to teaching. For example, students became confused about what analysis is and what synthesis is going so far as to skip one or both parts in their own processes. An example on improving upon how synthesis is taught might be to introduce is sooner with a practice example.

The process could be presented by giving students an example set of data, similar to the types of data they might collect as a part of a design project, and then guiding them through the process of organizing the data, building connections, and synthesizing. Then they would be guided in developing insights which is what would be used to guide the ideation. This guided process of analyzing and synthesizing data would help students to understand the process as well as the importance of synthesis prior to having to analyze and synthesize data as a part of their projects.

Lastly, the type of feedback given to students is important to consider. Feedback often motivated students to work harder on their projects. In addition, feedback was often related to the emotions of students. This, too, might be something to consider when it comes to providing students with feedback on their work. For example, when students received positive feedback they were motivated to work more, explore more, and continue to improve their designs. This was true of both feedback from peers and from the instructor. One example of peer feedback occurred early in the project when Blake requested to work with his team members but his requests were ignored so he left class. This is in contrast to George and Ryan who received positive feedback from both their peers and instructors, propelling them forward in the project, helping them stay motivated.

This research provides some considerations when it comes to teaching such as the structure of the design process and projects, the methods used to teach synthesis, and the way in which feedback is given to students. The suggestions here are only a start but it suggests that teaching methods should be considered related to the design process in order to guide students through projects, leading them to a successful outcome.

Diagnostic Tool

The outcomes of this study is not to suggest new ways to approach the design process as a whole. It is not meant to restructure the design process or to depict it in a new way. Instead it opens up opportunities for instructors, students, and designers to step back and understand their own or their students design processes, almost using the themes as a diagnostic tool. One can learn about their own or their students' strengths and weaknesses throughout the design process, seek out ways to improve in areas in which they are lacking, and use their strengths to their advantage.

Research Question

What happens to research throughout the design process is a broad question with a complex answer. The answer varies with each designer based on their experience, knowledge, how much they like a project, feedback they receive, how they were taught research, analysis, and synthesis, their learning styles, and more. This study did not cover all aspects of what happens to research throughout the design process as the scope of such a study would need to be very large including more students. Though this being the case we do have some answers about what is happening, at least enough to start questioning the expectations we have regarding the design process.

There are, of course, previously identified problems that occur such as fixation (Cross, 2001) in which designers get so wrapped up in one idea that they don't explore further, may not solve the problem, continually try to fix the idea they had to try and make it work, or even conduct research which says their idea is best even if it is not. This is not new information as it has been identified in multiple studies by Nigel Cross yet is mentioned because it did occur, confirming again that this is a problem.

Another problem that often occurs is that students can become confused about specific terms (such as analysis) or do not understand how to complete a vital task (such as synthesis). This issue leads to a lack of analysis and synthesis followed by difficulty to or inability to effectively use their research to guide their design process.

Tied to this are general problems occurring in the research phase of the design process. These problems range from not completing tasks (journey maps, for example) to using one self for collecting data to skipping most of the research process altogether. With problems such as these, the data set collected is not as rich as it could be, extending into problems in analysis, synthesis, and further into ideation and design contributing to designing a product which may not meet the user's needs.

Ideation methods were used to varying degrees by the students observed from one student developing their own method for generating ideas to others relying on research to guide their idea generation. Some students relied heavily on their research to guide design decisions while another relied heavily on their ideations methods and process to guide design decisions. Ideation is not so much a contributing factor in what happens to research as it is a step which defines the students own design process in regard to research. What this means is that some students thrive in research while others thrive in ideation. These are points that should be considered in evaluating and understanding the design process as it varies from student to student rather than it being a one size fits all as our expectations might tell us.

Synthesis too is its own theme. This is because of how significant the problems that occurred regarding synthesis were during the project. For the most part synthesis did not occur. For some students, a lack of data collection prevented any synthesis from happening because there was not enough data to synthesize to begin with. For other students, while they collected a

lot of data, they did not synthesize it. This, along with exploring a problem they did not know about, led to continued data collection as questions came up or problems occurred rather than having a guiding principle one can reference as questions arise.

As presented in Chapter 1, the design process is depicted as fairly linear though it is acknowledged by many as much more complex and iterative. As we can see when looking at the intended project timeline, the project was structured to be linear as well. However, the reality is much different. Based on observations, each students design process, or timeline, was outlined. The interesting thing here is that not only were the processes not linear- for the most part- they were not always iterative either. Even more interesting is that even though it is recognized that the design process is not linear, project timeline's are still created on the basis that it will be a linear process. The evidence points to a need to reconsider how projects are structured. If we recognize the process is not linear, should we not show and teach it in a non-linear fashion?

This is not to say that the design process as taught is wrong. Indeed it is necessary for students to explore each of the four stages first so that students might learn about each stage of the process, learning and finding their strengths and weaknesses. This is where the benefit of recognizing a project as not linear lies. In understanding each students design processes we can see what their strengths and weaknesses are. From there that information can be used to help students improve their own processes in order to have a better outcome at the end of the project.

Limitations

There are five main limitations that will be discussed here. The first being the size of the study. The observations focused on four students (three projects) making it difficult to generalize the data. The study only observed four students at one university, in one class. There are a couple reasons that led to this being a limitation. The first being that only one person was conducting the

observations. The other is time constraints. Each class session lasted three hours and took place two to three times per week. With only one observer, this led to the limitation of only being able to observe in one class.

The next limitation is related to this. Only the interactions and work that took place during class time were directly observed. Any work done outside of those hours could not be observed due to time and logistics. Students might spend brief to long periods of time on work outside of class time on a non-scheduled basis, at times working sporadically (as opposed to the scheduled class time) at all hours of the day and night.

This study focused mainly on the students, the work they produced, and the interactions they had. The only time the instructor was included in the observations was during direct interactions with the students being observed or when the entire class was being addressed such as during lectures, presentations, or demonstrations. More instructor observation could potentially lead to more information on what is happening throughout the design process.

Another limitation of the study is that it only focused on the design process of junior industrial design students. The question remains whether the same themes would occur were someone to observe sophomore students, senior students, or even working professionals. In relation to this is that the study only considered industrial design students, not students from other, related majors that might also use a design process.

Lastly, this study only considered the design process of students at one university. It did not consider the design process of students at other universities in different states or countries which could also provide valuable insight into the design process.

Future Work

The limitations of this study present some logical next steps for future work. Increasing the size and depth of the study to focus on a larger number of students, in a larger number of classes would be one direction for future work. This could be scaled to be studied in more universities in a variety of countries. By comparing the outcomes of the design process from students from a variety of countries who all have a different history of design and teach design differently would provide a larger variety of results.

Another area of future work to be considered is to study synthesis in order to understand why students struggle with synthesis. This might be to consider how synthesis is taught, interpreted or understood, implemented, whether it's successful or not, and why. Some questions related to this are: Is synthesis being taught students way they can be understand? Are the methods useful? Are the methods thorough enough? Are the methods too complicated to be effectively used? Is there something else impacting the quality of synthesis conducted? These are all questions that can be explored in relation to synthesis.

This study focused solely on industrial design students in the beginning of their junior, or third, year. Studying these topics with industrial designers at the sophomore level, junior level, and even working professionals would be another suggestion for future work. Related to this would be to compare the design process between different, related disciplines that might also be using a similar design process.

One area that this research starts to hint at is that designers design differently. This would be similar to the theory of multiple intelligences that suggests that people have a differing set of skills. (Gardner, 2006, p. 6) It might be worth understanding what designers intelligences are

based on this theory or even to determine if there are true differences in how designers design and how those design intelligences might be described.

There are likely many other areas of study for future work. The areas suggested here are based on the work done and the limitations discussed; it is likely that any future work conducted would suggest further directions of research.

Contributions to the Field

This research is a starting point. It opens up the idea that because students learn differently, they might also design differently. It also opens up the potential for better understanding what is happening in the design process of students and asks how we can help students develop a process that better suits their needs in order to achieve positive outcomes. Lastly, based on this research, we can question the current ways in which we depict and teach the design process as a "one size fits most" approach. The design process is not "one size fits most" and it's not in four neat phases or perfect little bubbles leading you from one phase into the next. Instead the design process is complicated and varying based on a variety of factors that occur. For students, this includes what they are taught, how they are taught, emotions they have, feedback they receive, among other factors. Certainly more research needs to be done in order to better understand what is happening to research throughout the design process but the question has been opened for consideration and discussion.

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APPENDIX A

REFLECTION INTERVIEWS

Interview Questions

List of interview questions asked in the reflection interviews. Follow-up questions in addition to these were asked at times to clarify or for additional information.

1. Why did you design this in this way?
2. What research methods were most effective?
3. What research methods were least effective?
4. Are there any that you skipped?
5. How did you use the research methods in the design?
6. Can you pin point when the idea came up?
7. Was the research useful in further developing your design?
8. When did you create objectives?
9. Talk about ideation.

APPENDIX B

COURSE DOCUMENTS

FALL 2016

DESIGNING FOR HEALTHY HABITS

WEEK / TO DO	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	WEEKLY DELIVERABLES
WEEK 5, 9/19	Feedback session project 1. Note: two competition opportunities C2C Design Challenge and Housewares. Project 2 kick off. Design a product that fosters healthy habits. What are healthy habits? What are unhealthy habits? What are 'healthy' products, 'unhealthy' products? **Research Blitz, 15 minutes, pin up. 5W+H, mind mapping, journey mapping What problem do you try to solve? What are research questions? Build teams of 4.**	Interviews (shadowing) Types of mapping: biaxial, semantic, affinity	**Pin up initial problem statement and research questions. 4 journey maps.** In class: Preliminary journey map analysis, pain points, identify habits. End of class, clear research plan for user research and market research. Which behavior are you designing for?	In-class activity: semantic differentials		***Preliminary Problem Statement & Research Questions, 4 journey maps, 10%***
TO DO	*Start to identify opportunities for design. Conduct contextual research and interviews. Develop 4 journey maps based on 4 very different people.*		*Continue user research & market research. Familiarize yourself with International Housewares Competition. https://www.housewares.org/show/sdc*			
WEEK 6, 9/26	**Pin up: 8 journey maps and preliminary insights. Insights from user research. Identified habits and design opportunities.** Work in class: visualization of market research, 2D concept development through idea sketches based on lotus blossom ideation technique. Break up in teams of 2. **End of class: refine design opportunities, define design objectives and design criteria.**	Study guide review #1	**Pin up: Idea sketches.** In class: critique. Lecture, smart process book design. How to turn it into a presentation? Continue concept iteration through 2D study sketches and 3D sketch models. Finish market research. **End of class: Finalize visualization of market research**	Quiz #1		***User research/journey maps, synthesis, opportunities for design, design objectives, design criteria. Visualization of market research. 15% Idea sketches, sketch models. 10%***
TO DO	*Ideation and market research.*		*Explore variations within direction. Find inspiration in existing products. 2D study sketches, 3D sketch models*			
WEEK 7, 10/3	**Pin up: Final concept idea. 2D study sketch & 3D sketch model.** In class: use scenarios and storyboards.	Persona	**Process book draft due. Refined use scenarios.** Work in class on concept testing and refinement. **End of class: Test model**	Activity analysis		***Refinement: study sketches, test models 15%*** ***Use scenarios, user testing, 10%***
TO DO	*Process book draft. Refined use scenarios, 2D information sketches and 3D test model*		*Process book, test model*			
WEEK 8, 10/10	Work in class. **Appearance model done 50%. Process book draft. Presentation draft. 2D detail drawings.**	Card Sorting	**Process book. Presentation rehearsal, model 90% done.** Work in class.	Cultural Probes	**2 min elevator pitch per team, appearance model, process book preferably printed.**	***Process book, 15%*** ***Presentation, 10%*** ***Appearance Model 15 (all including drafts?***
TO DO	*Process book, model, presentation*		*Print process book, refine presentation*			

[redacted]

[redacted]

Industrial Design Studio III

[redacted]

Instructors:

[redacted]

[redacted]

[redacted]

Project 2 Brief – Designing for Healthy Habits

Project Objective:
The intent of this project is to apply and further explore methods and tools used to design a home product. The students will follow sustainable design practices while practicing acquired knowledge and skills in product design.

The goal of this second studio project is to allow the students to practice their previously acquired knowledge and skills gained to develop design solutions addressing the real-life design issues identified in the problem statement.

Students will practice to communicate their work in both 2D and 3D, incorporate systems thinking exploring the entire eco-system of the product, think strategically about their processes and designs, incorporate structural and commercial aspects, apply creative problem solving and design research, as well as properly document and professionally present the designs and their thought and design making processes.

Project Description

Students will design a household equipment that promotes healthy habits.
Working in teams of 3 or 4, students will identify opportunities for design and an overall theme for the team. The teams break up into two smaller groups, each will design one product that fits the overall theme. The concepts should be considered part of a larger system of products and or service. The larger team will serve as bouncing board throughout the product development and all will present their work together week 8, Friday 10/13 between the morning and afternoon sketch sessions with [redacted]

Process
In the teams, students will conduct contextual research and interviews with a wide group of people. The focus is on discovering patterns of habits across these different people. The data will be visualized through journey maps. Common themes of habits and pain points will be identified and serve as opportunities for design. The market research will be geared towards

these areas of opportunities. A set of product objectives and more specific design criteria will be the guiding elements for the concept development of the smaller groups.
The smaller groups will generate a multitude of ideas, select one concept for refinement, iterate ideas based on user testing and research, define a design solution, build a full scale model made out of real (or simulated) materials. The final outcomes of each larger team will be presented as a whole and supported by a process book and presentation.
The students will apply the double diamond design process of diverging and converging in an iterative manner throughout the process.

Project Outcomes
The following project outcomes indicate competencies and measurable skills that students develop as a result of completing this project:

- Product concept: appearance model, process book, presentation
- Identifiable application of iterative design process and methods
- Integration of sustainable design methodology

Project Deliverables
Interim Deliverables, all to be pinned up before class, uploaded to cybox, presented and discussed in class:

Large group
- Initial research
- Research questions
- Visualization of user research through journey mapping
- Identification of opportunities
- Visualization of market research through several gap analysis matrices
- Design objectives and specific design criteria

Smaller groups
- Theme Development
- Concept ideation using lotus blossom method, quick idea sketches
- Concept iteration 2D study sketches and 3D sketch models
- Concept refinement 2D information sketches and 3D test models
- Use scenarios and storyboards (sketched or photo series using test models)
- User Testing
- Detail drawing and rendering
- Appearance model

Large group
- Process Book draft
- Presentation draft

Final Deliverables for large team, Friday [redacted] Open House presentations
- Process book, printed optional
- Presentation, digital
- 2 Appearance Models

[redacted]

Department of Industrial Design

Project Schedule: TBD

Monday 09/19 In class: Feedback session project 1. Project 2 kick off. What are healthy habits? What are unhealthy habits? What are 'healthy' products, 'unhealthy' products? Research Blitz, 15 minutes, pin up. 5W+H, mind mapping, journey mapping Teams of 4.	**Wednesday 09/21** **Pin up initial problem statement and research questions. 4 journey maps.** In class: Preliminary journey map analysis, pain points, identify habits. **End of class, clear research plan for user research and market research.** Which behavior are you designing for?	
Monday 09/26 **Pin up: 8 journey maps and preliminary insights. Insights from user research. Identified habits and design opportunities.** Work in class: visualization of market research, 2D concept development through idea sketches based on lotus blossom ideation technique. Break up in teams of 2. **End of class: refine design opportunities, define design objectives and design criteria.**	**Wednesday 09/28** **Pin up: Idea sketches.** In class: critique. Lecture, smart process book design. How to turn it into a presentation? Continue concept iteration through 2D study sketches and 3D sketch models. Finish market research. **End of class: Finalize visualization of market research**	
Monday 10/03 **Pin up: Final concept idea. 2D study sketch & 3D sketch model.** In class: use scenarios and storyboards.	**Wednesday 10/05** **Process book draft due. Refined use scenarios.** Work in class on concept testing and refinement. **End of class: Test model**	
Monday 10/10 **Appearance model done 50%. Process book draft. Presentation draft.** Work in class. 2D detail drawings.	**Process book. Presentation rehearsal, model 90% done. Work in class.**	**Friday 10/14** [redacted]Open Salon Presentation on individual laptops appearance model process book

Grading Criteria: TBD

60% Interim Deliverables

- 10% Preliminary Problem Statement & Research Questions, 4 journey maps
- 15% User research/journey maps, synthesis, opportunities for design, design objectives, design criteria. Visualization of market research.
- 10% Idea sketches, sketch models
- 15% study sketches, test models
- 10% Use scenarios, user testing

40% Final Deliverables (all including drafts)

- 15% Process book
- 10% Presentation
- 15% Appearance Model

[redacted]

Department of Industrial Design

Assignments:
Assignment 1
DUE: Wednesday, September 21
Identify initial problem statement and research questions.
Conduct contextual research, observations, and interviews.
Four journey maps.

Assignment 2
DUE: Monday, September 26
Eight journey maps
Insights from user research. Identified habits and design opportunities.
End of class: Refined opportunities, defined design objectives and design criteria.

Assignment 3
DUE: Wednesday, September 28
Ideation and material exploration. Idea Sketches.
End of class: Visualization of market research.

Assignment 4
DUE: Monday, October 3
Start detailing the design:

- Explore variations within direction. 2D study sketches, 3D sketch and test models.
- Find inspiration in existing products.
- Look for opportunities to refine.
- Attention to detail is key!

Assignment 5
DUE: Wednesday, October 5
Use scenarios. Process book draft.
End of class: test model.

Assignment 6
DUE: Monday, October 10
Process book draft, presentation draft
Appearance model done 50%
End of class: 2D detail drawings

Assignment 7
DUE: Wednesday, October 12
Digital process book, refine presentation
Appearance model done 90%

Assignment 8
DUE: Friday, October 14

- Final Process book
- Final Presentation
- Final Appearance Model

APPENDIX C

IRB APPROVAL

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
1138 Pearson Hall
Ames, Iowa 50011-2207
515 294-4566
FAX 515 294-4267

Date: 8/19/2016

To: Monica Amman
4416 Toronto St. Apt 4
Ames, IA 50014

CC: Dr. Steven Herrnstadt
162 Design Building
Dr. Seda Yilmaz
146 Design

From: Office for Responsible Research

Title: Transitions in the Design Process

IRB ID: 16-346

Approval Date:	8/19/2016	**Date for Continuing Review:**	8/1/2018
Submission Type:	New	**Review Type:**	Full Committee

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University according to the dates shown above. Please refer to the IRB ID number shown above in all correspondence regarding this study.

To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 56), please be sure to:

- **Use only the approved study materials** in your research, **including the recruitment materials and informed consent documents that have the IRB approval stamp**.
- **Retain signed informed consent documents for 3 years after the close of the study,** when documented consent is required.
- **Obtain IRB approval prior to implementing any changes** to the study by submitting a Modification Form for Non-Exempt Research or Amendment for Personnel Changes form, as necessary.
- **Immediately inform the IRB of** (1) **all serious and/or unexpected adverse experiences** involving risks to subjects or others; and (2) **any other unanticipated problems involving risks** to subjects or others.
- **Stop all research activity if IRB approval lapses**, unless continuation is necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.
- **Complete a new continuing review form** at least three to four weeks prior to the **date for continuing review** as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Please be aware that IRB approval means that you have met the requirements of federal regulations and ISU policies governing human subjects research. **Approval from other entities may also be needed.** For example, access to data from private records (e.g. student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. **IRB approval in no way implies or guarantees that permission from these other entities will be granted.**

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 202 Kingland, to officially close the project.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.